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Research related to the quality of irrigation return flow is being conducted at numerous institutions throughout the western United States. Related work is also underway at other institutions in the United States, as well as other portions of the world. Approximately 100 sources of material have been searched for articles pertinent to the National Irrigation Return Flow Research and Development Program. These articles describe water quality problems resulting from irrigated agriculture, potential technological solutions for controlling return flows, recent research pertinent to return flow investigations, and literature associated with institutional constraints in irrigation return flow quality control. The first annual issue of SELECTED IRRIGATION RETURN FLOW QUALITY ABSTRACTS covered publications printed in 1968 and 1969, while the second annual issue lists publications printed in 1970 and 1971, and the third annual issue covers calendar years 1972 and 1973, and the fourth annual issue lists abstracts of 1974 publications. This annual issue lists 501 publications printed in 1975. This report was submitted in fulfillment of Grant Number R-800426 under the sponsorship of the Office of Research and Development, Environmental Protection Agency.
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SELECTED IRRIGATION RETURN FLOW QUALITY ABSTRACTS 1975

Fifth Annual Issue

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FOREWORD

The fifth annual issue of SELECTED IRRIGATION RETURN FLOW QUALITY ABSTRACTS has been compiled from approximately 100 sources of material covering calendar year 1975. This compilation has attempted to include technological and institutional articles that would be pertinent to action programs regarding the control of water quality degradation resulting from irrigated agriculture.

The state-of-the-art report, "Characteristics and Pollution Problems of Irrigation Return Flow" prepared by the Utah State University Foundation contains a bibliography of articles pertinent to Irrigation Return Flow Quality through 1967. The first annual issue of SELECTED IRRIGATION RETURN FLOW QUALITY ABSTRACTS listed publications appearing in calendar years 1968 and 1969, while the second annual issue listed publications appearing in calendar years 1970 and 1971, the third annual issue contained abstracts of articles and reports published during calendar years 1972 and 1973, and the fourth annual issue contains abstracts of 1974 publications. The fifth annual issue contains 501 abstracts of documents published during calendar year 1975. The abstracts have been placed into sections according to the category and subgroup classifications used by the Water Resources Scientific Information Center (WRSIC) as published in the report, "Water Resources Thesaurus." The abstracts have been forwarded to WRSIC for inclusion in their bi-monthly publication, "Selected Water Resources Abstracts."

ABSTRACT

Research related to the quality of irrigation return flow is being conducted at numerous institutions throughout the western United States. Related work is also underway at other institutions in the United States, as well as other portions of the world. Approximately 100 sources of material have been searched for articles pertinent to the National Irrigation Return Flow Research and Development Program. These articles describe water quality problems resulting from irrigated agriculture, potential technological solutions for controlling return flows, recent research pertinent to return flow investigations, and literature associated with institutional constraints in irrigation return flow quality control.

The first annual issue of SELECTED IRRIGATION RETURN FLOW QUALITY ABSTRACTS covered publications printed in 1968 and 1969, while the second annual issue lists publications printed in 1970 and 1971, the third annual issue covers calendar years 1972 and 1973, and the fourth annual issue covers literature published in 1974. This annual issue lists publications printed in 1975. This report was submitted in fulfillment of Grant Number R-800426 under the sponsorship of the Office of Research and Development, Environmental Protection Agency.

Key Words: Fertilizers, Irrigated Land, Irrigation Systems, Irrigation Water, Nitrates, Phosphates, Return Flow, Salinity, Water Pollution Effects, Water Pollution Sources, Water Quality Control.

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The efforts of Mrs. Debby Wilson and Ms. Carole Pflug in preparing the necessary forms which are forwarded to the Water Resources Scientific Information Center are sincerely appreciated, as well as the typing of this final report.

The scope of this literature abstracting effort has been delineated jointly by the senior author and the Project Officer, Dr. James P. Law, Jr., Chief, Irrigated Agriculture Section, Source Management Branch, Robert S. Kerr Environmental Research Laboratory, Environmental Protection Agency, Ada, Oklahoma. The cooperative efforts of the Project Officer in meeting with project personnel and reviewing the abstracting process have been very helpful and are sincerely appreciated.

Section I

WATER CYCLE

GENERAL (GROUP 02A)

75:02A-001
RAINFALL-INDUCED RUNOFF COMPUTED FOR FALLOW FIELDS,
Hauser, V.L., Hiler, E.A.
Agricultural Research Service, Durant, Oklahoma, Water Quality Management
Laboratory.
Transactions of American Society of Agricultural Engineers, Vol. 18, No. 1,
p 122-125, January-February 1975. 5 fig, 1 tab, 13 ref.

Descriptors: Hydrology, *Great Plains, *Agriculture, *Equations, *Rainfall-runoff relationships, Runoff, Agricultural runoff, Surface runoff, Rainfall intensity, Rainfall, Solar radiation, Sheet erosion, Suspended load, Texas, Kansas, Iowa, Forecasting, *Runoff Forecasting.

There are no long-term runoff records available that could be used to determine the needed runoff amount or return-frequency information for the western Great Plains; however, management of this water can increase yields. Rainfall amount and intensity, runoff, and soil water were measured on 3 terraced fields for 13 years. The soil was clay loam and had a slowly permeable layer; the average land slope was 1.5%. The fields were cropped in a wheat-sorghum-fallow sequence which gave 22 months of fallow for each 36-month period. Stubble mulch tillage was used to control wind and water erosion. A set of equations was developed to compute rainfall-induced runoff from fallow land with the use of daily rainfall, maximum 1-hr rainfall for the day, and computed soil water content. Equations were computed for three conditions (1) soil water content greater than field capacity, (2) fallow-after-wheat from June to January, and (3) fallow-after-sorghum plus after wheat January to June. About 15% more runoff was computed than was measured on a fallow period basis; however, a linear correction reduced the error to 4.6%. The following conclusions were drawn from the study: (1) the equations for soil water can be used to compute runoff from rainfall records; (2) soil water content may be computed and used successfully in runoff equations; (3) daily runoff can be computed accurately with inputs of daily rainfall, computed soil water content, and maximum 1-hr rainfall for the day; and (4) the use of computed soil water content permits the equation set to compute runoff for the whole year.

75:02A-002
NUTRIENT AND SEDIMENT DISCHARGE FROM AGRICULTURAL WATERSHEDS IN OKLAHOMA,
Olness, A., Smith, S.J., Rhoades, E.D., and Menzel, R.G.
Agricultural Research Service, Durant, Oklahoma. Water Quality Management Lab.
Journal of Environmental Quality, Vol. 4, No. 3, p 331-336, July-September, 1975.
1 fig, 3 tab, 19 ref.

Descriptors: *Surface runoff, *Sediment yield, *Agricultural watersheds, *Nitrogen, *Phosphorus, *Ranges, Nutrients, Chemical analysis, Watershed management, Cultivated lands, Fertilizers, Oklahoma, Soil erosion, Precipitation(Atmospheric), Rainfall-runoff relationships, Runoff, Topsoil, Vegetation effects, Nitrates, Grazing, Range management.

Seven cropland watersheds and four rangeland watersheds in central Oklahoma were monitored for surface hydrology and discharge of nitrogen, phosphorus, and sediment over a 1 year period in which precipitation and runoff were much above normal. Sediment losses from the continuously grazed rangeland watersheds ranged from 10 to 23 metric tons/hectare during the study. None of the sediment losses from the other watersheds exceeded 10 metric tons/hectare. Total nutrients discharged in runoff ranged from 3 to 15 kilograms/hectare of N and 1 to 11.5 kilograms/hectare of P. Flow-weighted mean concentrations ranged from 1 to 6 parts per million of total N, 0.2 to 1.0 ppm of nitrate-N, 0.5 to 4.0 ppm of total P, and 0.04 to 0.9 ppm of soluble P. Cropland watersheds had much greater concentrations of soluble phosphorus in runoff than rangeland watersheds. Loss of fertilizer N and P did not exceed 5 percent of the most recent applications, even though surface runoff was 4 to 10 times greater than that observed in previous years.

75:02A-001
A COMBINED MODEL OF WATER TABLE AND RIVER STAGE EVOLUTION,
Morel-Seytoux, H.J.
Colorado State University, Fort Collins, Engineering Research Center.
Water Resources Research, Vol. 11, No. 6, p 968-972, December 1975. 25 ref.

Descriptors: *Surface-groundwater relationships, Streamflow, *Aquifer systems, *Aquifer characteristics, *Groundwater movement, *Simulation analysis, *Model studies, Aquifers, Pumping, Flood stages, Flood flow, Return flow, Hydrology, Hydraulics, Momentum equation.

An integral equation was derived which completely characterizes the interaction between a stream and the alluvial aquifer. Expressed in finite difference form, the equation was of great practical utility in solving flooding problems (i.e., negligible effect of pumping on river flows) as it relates river stage to return flows. It was also useful to solve pure conjunctive use of surface water and groundwater problems (i.e., negligible river stage fluctuations) as it relates return flows to pumping rates, or to solve composite problems. The numerical procedures to calculate the response function coefficients in terms of the physical characteristics of the system were given in detail.

Section II

WATER CYCLE

PRECIPITATION (GROUP 2B)

75:02B-001
HYDROLOGIC IMPACT OF WEATHER MODIFICATION,
Seely, E.H.; DeCoursey, D.G.
United States Department of Agriculture, Agricultural Research Service, P.O. Box 400, Chickasha, OK 73018
Water Resources Bulletin, Vol. 11, No. 2, p 365-369, April 1975. 9 ref.

Descriptors: *Weather modification, *Hydrologic systems, Hydrology, Water supply, Water supply development.

Weather modification is being proposed as a routine method of augmenting agricultural water supplies in the Southern Great Plains. This paper discusses some of the potential hydrologic impacts of weather modification. Previous work in assessing hydrologic impact is covered; the conclusion is drawn that the work is insufficient. An approach based on hydrologic models is suggested that can consider uncertainties about the effect of weather modification on rainfall and some uncertainties about the effect of model error on impact conclusions.

Section III

WATER CYCLE

SNOW, ICE, AND FROST (GROUP 02C)

75:02C-001
OBSERVATIONS OF STAGE, DISCHARGE, PH, AND ELECTRICAL CONDUCTIVITY DURING PERIODS OF ICE FORMATION IN A SMALL SUBARCTIC STREAM,
Osterkamp, T.E.; Gilfilian, R.E., and Benson, C.S.
Alaska University, College. Geophysical Institute.
Water Resources Research, Vol. 11, No. 2, p 268-272, April 1975. 6 fig, 16 ref.

Descriptors: *Ice, *Streamflow, *Electrical conductance, Conductivity, Frazil ice, Freezing, Permafrost, Discharge(Water), Flow profiles, Discharge measurement, Water levels, Hydrogen ion concentration, *Subarctic, Streams, *Alaska.

Ice formation in a small subarctic stream modified the stage, velocity profiles, discharge, and electrical conductivity, while the pH remained nearly constant. Frazil ice crystals suspended in the flow reduced the velocity profiles and increased the stage. Anchor ice and border ice growth decreased the discharge by 11 and 55% for two periods of underwater ice production. These reductions in discharge may be attributed to storage in the form of ice and to upstream water storage caused by increased flow resistance in the stream. The increase in the electrical conductivity of the stream water during periods of ice production was related to the concentration of ice in the stream. Ice concentrations calculated from this increase in conductivity were 1.8, 0.9, and 4.7% (by volume) for the first 150 min of three different periods of ice production.

75:02C-002
COMPUTER SIMULATION OF THE SNOWMELT AND SOIL THERMAL REGIME AT BARROW, ALASKA,
Outcalt, S.I.; Goodwin, C.; Weller, G.; Brown, J.
Michigan University, Ann Arbor. Department of Geography.
Water Resources Research, Vol. 11, No. 5, p 709-715, October 1975. 3 fig, 1 tab, 17 ref.

Descriptors: Computer models, *Snowmelt, *Soils, *Alaska, Tundra, Temperature, Model studies, Water supply, Freshwater, Melt water, Snow, Arctic.

An annual snow-soil simulator for arctic tundra was developed by using coupled models of surface equilibrium temperature and substrate thermal diffusion. Snow ripening, melt, and accumulation were modeled in the simulator which was forced with daily weather data. The simulator predicted that a snow fence array capable of producing drift deeper than 4.2 m would initiate a permanent snowfield at Barrow, Alaska. Such a man-induced snowfield could serve as a reliable source of freshwater for Barrow and similar villages in the north slope region of Alaska. Further analysis indicated that albedo reduction due to dust fall, snow removal, etc., was dominant over aerodynamic effects in producing the early spring meltout observed at Barrow Village.

Section IV

WATER CYCLE

EVAPORATION AND TRANSPIRATION (GROUP 02D)

75:02D-001
SIMULATION MODEL FOR EVAPOTRANSPIRATION OF WHEAT: EFFECT OF EVAPORATIVE CONDITIONS,
Strateener, G., Yaron, D., Bresler, E., and Shimshi, D.
Hebrew University, Jerusalem (Israel).
Journal of the Irrigation and Drainage Division, Proceeding of American Society of Civil Engineers, Vol 101, No IR1, Proceedings Paper 11169, p 13-19, March 1975. 4 tab, 3 ref, 2 append.

Descriptors: *Evapotranspiration, *Simulation analysis, *Agriculture, *Irrigation, *Wheat, Consumptive use, Soil moisture, Evaporation, Computers, Computer programs, Field capacity, Regression analysis, Plant growth, Root systems, Soil profiles, Model studies, Evaporation pans, Canopy.

A simulation model for tracing soil moisture fluctuations under irrigated wheat in a semi-arid climate was presented. The model was based on a function relating evapotranspiration to soil moisture and evaporative conditions as measured by means of a class A pan. The recharge of soil moisture by rain or irrigation was predicted by this model on the basis of a simplified infiltration scheme with the conventional concept of 'field capacity' as the upper limit of soil moisture in the soil profile. By means of an iterative procedure, the 'best fitting' parameters were computed for each soil layer and each month from data on a wheat irrigation experiment in the arid Negev region in the year 1967-1968. The average relative deviation of the predicted soil moisture from the observed soil moisture was 9.3% for the five soil layers and 6.2% for the upper three soil layers. The reliability of the model was presented by these and other data and its performance was examined.

75:02D-002
SIMULATION MODEL FOR EVAPOTRANSPIRATION OF WHEAT: EMPIRICAL APPROACH,
Shimshi, D., Yaron, D., Bresler, E., Weisbrod, M., and Strateener, G.
Agricultural Research Organization, Bet Dagan (Israel). Institute of Soils and Water.
Journal of the Irrigation and Drainage Division, American Society of Civil Engineers, Vol 101, No IR1, Proceedings Paper 11170, p 1-12, March 1975. 2 fig, 4 tab, 16 ref, 2 append.

Descriptors: *Evapotranspiration, *Wheat, *Simulation analysis, Agriculture, *Soil water, Root zone, Irrigation, Rain water, Arid lands, Infiltration, Soil surfaces, Wetting, Field capacity, Water loss, Root systems, Soil profiles, Canopy, Evaporation, *Model studies.

A simulation model was described for predicting the changes in the soil-water content of the root zone of wheat growing under various irrigation regimes in a semi-arid region. The model was based on the following assumptions: (1) irrigation water and rainwater infiltrates from the soil surface, wetting each successive soil layer as the overlying one is wetted in excess of the field capacity (as conventionally defined); and (2) the rate of water loss from the soil changes with time and with depth of soil. Parameters were determined empirically from soil moisture data collected from a series of wheat irrigation experiments carried out over a 4-year period in northern Negev, Israel. The average relative deviation between computed and observed values of soil moisture ranged from 6.8 to 11.5%. The changes in parameters reflected the development of the root system in the soil profile and the changes in time of canopy cover and evaporation conditions.

75:02D-003
PERSISTENCE OF SELECTED ANTITRANSPIRANTS,
Kreith, F., Taori, A., and Anderson, J.E.

Colorado University, Boulder. Department of Chemical Engineering.
Water Resources Research, Vol 11, No 2, p 281-286, April 1975. 5 fig, 15 ref.

Descriptors: *Antitranspirants, *Persistence, *Tobacco, Water vapor, Phenols, Sprays, Leaves, Water loss, Transpiration, Transpiration control, Analytical techniques, Ecology, Laboratory tests.

The short- and long-term effectiveness of two film-forming and two physiologically active antitranspirants was evaluated on tobacco leaves under controlled experimental conditions. The physiologically active antitranspirants (phenylmercuric acetate and monoglycerol ester of n-decenyl succinic acid) initially reduced water loss to less than 40% of controls, but their effectiveness diminished sharply within 2-3 days. Treatment with the film-forming antitranspirants (Wilt Pruf and Mobileaf) resulted in initial transpiration reductions to 50-65% of controls, but the duration of effectiveness was longer with these than with the metabolic agents. The results were compared with those of previous studies, and implications for large-scale antitranspirant applications were discussed. Since the cost of water varied considerably in different parts of the world, the economic viability of using antitranspirants could not be ascertained by a technical study alone. Under conditions for which water is expensive or not available, the use of antitranspirants may be economical provided no adverse ecological effects occur.

75:02D-004
RESPONSE OF AN UNSATURATED SOIL TO FOREST TRANSPIRATION,
Parlange, J-Y, and Aylor, D.E.
Connecticut Agricultural Experiment Station, New Haven.
Water Resources Research, Vol 11, No 2, p 319-323, April 1975. 3 fig, 12 ref, 1 append.

Descriptors: *Transpiration, *Discharge(Water), *Forest watersheds, Evaporation, Diurnal, Saturated soils, Soil water, Soil Moisture, Hydrologic aspects, Water consumption, Seepage, Deep percolation, Cycles, Gravimetric analysis, Connecticut, Forests, Moisture content, Movement, *Connecticut.

Diurnal cycles in water outflow from a small watershed due to forest transpiration were observed 4 times during August 1973. Each time the daytime outflow was reduced significantly below that during the following night. The recovery of the outflow to the steady night level took place for several hours after sunset, and this time of recovery was shown to be controlled by the unsaturated soil water movement in the root zone. The observations of transpiration were made on a small area of a 5-acre forested watershed in North Madison, Connecticut, surrounding a lake. Water seeped from the lake into the observation plot and emerged on the other side where it passed through a weir and was monitored continuously. The difference between the amount of water seeping into the test plot from the lake and the measured outflow determined the evapotranspiration from the plot.

75:02D-005
AVERAGING ERRORS IN MONTHLY EVAPORATION ESTIMATES,
Hage, K.D.
Alberta University, Edmonton. Department of Geography.
Water Resources Research, Vol 11, No 2, p 359-361, April 1975. 2 tab, 6 ref.

Descriptors: *Evaporation, *Climatology, *Estimating, Temperature, Humidity, Environment, Wind velocity, Vapor pressure, Model studies, Hydrology, Heat flow, Latent heat, Weather, Data processing, Water temperature, Diffusion.

The problem of computing evaporation from monthly mean values of temperature, relative humidity, and wind was considered with specific reference to a Dalton-type evaporation formula. Leading contributions due to nonlinearities, covariances, and their interactions were identified separately by expanding saturation vapor pressure as a Taylor series in temperature with the use of the Clausius-Clapeyron equation. A truncated form of the expansion was tested by using observations from a land station. A crude model of diurnal variations in air temperature, relative humidity, and wind speed was used to predict nonlinearity and covariance evaporation errors from monthly mean observations at 2 times per day. The model appeared to be accurate to within plus or minus 4% in warm seasons months but failed in winter when diurnal variability was negligible in comparison with air mass changes in weather elements at mid-latitude continental locations. Covariance and nonlinearity errors did not compensate each other in winter and averaging errors could reach 20-25%.

75:02D-006
DIURNAL AND SEASONAL SOIL WATER UPTAKE AND FLUX WITHIN A BERMUDAGRASS ROOT ZONE,
Rice, R.C.
Agricultural Research Service, Phoenix, Arizona Water Conservation Lab.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 394-398, May-June 1975. 5 Fig, 3 tab, 9 ref.

Descriptors: *Evapotranspiration, *Soil water, *Unsaturated flow, *Hydraulic conductivity, Bermudagrass, Lawns, Water utilization, Root zone, Consumptive use, Irrigation, On-site investigations, Soil water movement, Soil moisture, Subsurface flow, Vegetation, Diurnal, Seasonal, Pressure head, Tensiometers.

Diurnal water movement within a bermudagrass root zone and the uptake of water by the roots was studied in a field plot. A fast response tensiometer-pressure-transducer system was used to measure the hydraulic head. The relations of pressure head to water content and to hydraulic conductivity were determined in situ. Diurnal water content and soil water flux profiles were derived by using the established hydraulic properties. The fast response tensiometer system enabled calculation of flux and water content changes over 2-hour intervals. Diurnal water extraction rates calculated for different depths and times during the growing season yielded evapotranspiration rates that agreed well with rates measured on similar days in previous years using a lysimeter. The water uptake pattern changes rapidly near the surface during the first few days after irrigation. Rewetting within the soil profile occurred in late afternoon at depths where upward gradients were present. The seasonal consumptive-use curve can be estimated from several daily evapotranspiration rates calculated during the growing season.

75:02D-007
CHANGES IN CLIMATE AND ESTIMATED EVAPORATION ACROSS A LARGE IRRIGATED AREA IN IDAHO,
Burman, R.D., Wright, J.L., Jensen, M.E.
Wyoming University, Laramie, Agricultural Engineering Department.
Transactions of the American Society of Agricultural Engineers, Vol. 18 No. 6, p 1089-1093, November-December. 7 Fig, 3 tab, 16 ref.

Descriptors: *Irrigation, *Irrigation effects, *Evaporation, *Climate, Idaho, Weather, Weather modification, Evapotranspiration.

Ground level climatic measurements were taken along a 50 km transect going from dry sagebrush land into the center of a large irrigated area in southern Idaho. Measurements in May, when the desert area was dry, indicated that climatic changes across the transect were minimal. In August when the desert was obviously very dry, air temperatures decreased, vapor pressure increased, and windspeed was reduced about 40 percent within the irrigated area. The results demonstrate that any weather service agency or group must consider the distance from dry surroundings when selecting sites that are to be representative of climatic conditions over irrigated fields.

75:02D-008
COMPARISON OF WARM WATER EVAPORATION EQUATIONS,
Weisman, R.N.
Canterbury, University, Christchurch, New Zealand. Department of Civil Engineering.
Journal of the Hydraulics Division, Vol. 101, No. HY10, p 1303-1313, October 1975. 3 Fig, 2 tab, 12 ref, 2 append.

Two methods of calculating evaporation from water bodies have been reviewed. In one method, a purely free convective term is added to a forced convective term under near neutral atmospheric conditions to obtain a total evaporation equation. In the second method, the results of a numerical solution to turbulent diffusion equations for conditions of simultaneous free and forced convection based on Monin-Obukhov similarity are used to calculate evaporation. The comparison of the results is approximate because the M-O type model contains a wind profile for unstable conditions is used. A wide range of wind speed, air and surface temperatures, and vapor pressures were assumed as input to the two models.

75:02D-009
EVAPOTRANSPIRATION OF DRYLAND BARLEY WITH DIFFERENT PLANT SPACING PATTERNS,
Luebs, R.E.; Laag, A.E.; Nash, P.A.
California University, Riverside.
Agronomy Journal, Vol. 67, No. 3, p 339-342, May-June, 1975. 1 fig, 3 tab, 8 ref.

Descriptors: *Evapotranspiration, *Crop production, *Crop response, *Planting management, *Barley, Drought resistance, Growth stages, Plant growth, Water requirements, Water utilization, Lysimeters, Soil moisture, Transpiration, Plant physiology, Soil-water-plant relationships, Moisture stress, Canopy.

Results are reported of an experiment which was conducted during the 1969-70 growing season near Riverside, California, to study the effect of plant spacing patterns of dryland barley (Hordeum vulgare L.) on leaf area index, crop canopy, evapotranspiration, and yield. The minimum unit area of equal plant population density for all spacing patterns was 240 sq cm. Crop canopy and leaf area index were lowest for the grid spacing pattern (8.1-cm row spacing with seeds spaced 7.4 cm in the row) largely because of less tillering. The paired-row pattern (8.1 cm spacing between rows in a pair and 32.3 cm between pairs with seeds spaced 3.7 cm in the row) had highest leaf area index but intermediate crop canopy during the vegetative phase with adequate water. Slightly greater evapotranspira- tion values were found during the first two-thirds of the growing season for the standard row pattern (16.1-cm row spacing with plants spaced 3.7 cm in the row) which resulted in greater water stress and lower evapotranspiration values later in the season, but grain yield was not affected.

75:02D-010
A THEORY FOR LOCAL EVAPORATION (OR HEAT TRANSFER) FROM ROUGH AND SMOOTH SURFACES AT GROUND LEVEL,
Brutsaert, W.
Cornell University, Ithaca, N.Y., School of Civil and Environmental Engineering.
Water Resources Research, Vol. 11, No. 4, p 543-550, August 1975. 7 fig, 40 ref.

Descriptors: *Evaporation, *Heat transfer, Atmosphere, Humidity, Shear, Turbulent flow, Eddies, *Model studies, Surface tension, Theoretical analysis, Interfaces, *Diffusion, Diffusivity, Drag, Shear stress.

A model proposed in 1965 for evaporation as a molecular diffusion process into a turbulent atmosphere was extended by joining it with the similarity models for turbulent transfer in the surface sublayer. The assumed mechanisms were suggested by available flow visualization studies near smooth and rough walls; the theoretical result was in good agreement with available experimental evidence. The important dimensionless parameters governing the phenomenon near the surface were the Dalton (or Stanton) number (i.e., mass transfer coefficient), the drag coefficient, the roughness Reynolds number (except for smooth surfaces), and the Schmidt (or Prandtl) number. The proposed formulation allowed the evaluation of the effects of some parameters, such as surface roughness or molecular diffusivity, that were not well understood before this. An important practical result was that, in contrast to the drag coefficient, the Dalton number is relatively insensitive to changes in roughness length.

75:02D-011
SIMULATION OF EVAPOTRANSPIRATION AND DRAINAGE FROM MATURE AND CLEAR-CUT DECIDUOUS FORESTS AND YOUNG PINE PLANTATION,

Swift, L.W., Swank, W.T., Mankin, J.B., Luxmoore, R.J., Goldstein, R.A.
Forest Service (USDA), Franklin, N.C. Coweeta Hydrologic Lab.
Water Resources Research, Vol. 11, No. 5, p 667-673, October 1975, 1 fig, 7 tab, 21 ref.

Descriptors: *Simulation analysis, *Evapotranspiration, *Drainage, *Deciduous forest, *Pine trees, *Appalachian Mountain Region, Soils, Atmosphere, Oak trees, Hickory trees, Hardwood, Watersheds(Basins), Vegetation, Meteorological data, Seasonal, Soil moisture, *Model studies.

Prosper, a phenomenological model of water exchange between soil, plant, and atmosphere, was used to simulate evapotranspiration and annual drainage for 2 years from a mature oak-hickory forest in the southern Appalachians. The simulation was tested by comparing drainage to measured streamflow. In a year of unusually high precipitation the simulated annual drainage was within 1.5% of measured streamflow. Simulations were also performed by using the same 2 years of meteorologic data, but vegetation parameters were changed to represent a young white pine plantation and a regrowing hardwood forest one year after clear-cutting. The model estimated that drainage for an average rainfall year was reduced 20 cm by a 16-year-old white pine plantation and increased 16 cm by clear-cutting. These results were comparable to changes of -20 and +18 cm observed in watershed experiments at Coweeta Hydrologic Laboratory. Simulated evapotranspiration during the summer was nearly identical for hardwood and pine forests, while winter and early spring water loss was greater for pine. Simulation suggested that the greater evapotranspiration by pine was due to increased interception in all seasons and increased transpiration in the dormant season. For the clearcut area, simulated evapotranspiration was considerably less than it was for the pine or hardwood forest and thus caused simulated soil moisture contents to be greater during the summer season.

75:02D-012
INCLUSION OF PLANT MOISTURE STATUS IN COMBINATION-METHOD ESTIMATES OF PASTURE EVAPORATION,
Shepherd, W.
Commonwealth Scientific and Industrial Research Organization, Aspendale (Australia) Div. of Atmospheric Physics.
Journal of Hydrology, Vol. 26, No. 3/4, p 199-207, August 1975. 3 fig, 1 tab, 10 ref.

Descriptors: *Evaporation, *Pastures, *Plant physiology, *Moisture, Energy budget, Moisture stress, Soil moisture, Grasslands.

A combination-type formula for estimation of evaporation under conditions of restricted water supply was considered in earlier work. The formula involved an 'internal conductance' factor. Relationships of the conductance to indexes of moisture status of pasture species, determined over a range of soil-moisture conditions, was described here. Once established, these relationships were employed to estimate conductances, which were then used to determine evaporation over later periods of pasture growth. The investigations demonstrated that inclusion of plant-moisture stress data into a combination formula could afford estimates of pasture evaporation which were significantly better than those obtained by more empirical means.

75:02D-013
ESTIMATING ENERGY BUDGET COMPONEN [illegible] O DETERMINE LAKE HURON EVAPORATION,
Bolsenga, S.J.
National Oceanic and Atmospheric Administration, Ann Arbor, Michigan, Great Lakes Environmental REsearch Lab.
Water Resources REsearch, Vol. 11, No. 5, p 661-666, October 1975. 2 fig, 3 tab, 22 ref.

Descriptors: *Evaporation, *Lake Huron, Energy budget, Mass transfer, Great Lakes, Energy, Heat flow, Advection, Lakes, Estimating.

Evaporation was estimated for Lake Huron by the energy budget method and compared to available mass transfer estimates. Data from representative shoreline station measurements and vessel cruise measurements were collected. Agreement between evaporation by the energy budget and by mass transfer was reasonable from February through July, with the exception of May when measurement of the heat content was a problem. For the remainder of the year the disparity was marked. The principal difficulty encountered was the lack of meteorological measurements on the lake and adequate techniques to extrapolate the quantities from shoreline data. Quantitative monthly values for each component in the budget equation were the first published for Lake Huron and one of the few data available for the Great Lakes.

Section V

WATER CYCLE

STREAMFLOW AND RUNOFF (GROUP 02E)

75:02E-001
OPTIMIZING PARAMETERS FOR A WATERSHED MODEL,
Shanholtz, V.O.; Carr, J.C.
Virginia Polytechnic Institute and State University, Blacksburg. Department of Agricultural Engineering.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 2, p 307-311, March-April 1975. 4 fig, 1 tab, 9 ref.

Descriptors: *Model studies, *Simulation analysis, *Computer models, Optimization, Hydrology, Analytical techniques, Hydrologic aspects, Runoff, Mathematical models, Mathematics, Watersheds (Basins), Parametric hydrology.

Use of the Kentucky Watershed Model and experimentation with various land phase parameters were discussed. Examples were present demonstrating the year-to-year parameter variation and the effect of including additional records. Potential errors due to unrepresentative, short periods of record were also discussed. When longer historical records were available, new criteria for selecting representative input data were presented.

75:02E-002
WATERSHED SOIL DETACHMENT AND TRANSPORTATION FACTORS,
Onstad, C.A.; Moldenhauer, W.C.
United States Department of Agriculture, Morris, Minnesota 56267
Journal of Environmental Quality, Vol. 4, No. 1, p 29-33, January-March 1975. 3 fig, 21 ref.

Descriptors: *Simulation analysis, *Model studies, *Sediment transport, Erosion, Erosion rates.

Quantification of sediment yields from agricultural watersheds requires that consideration be given to spatial and temporal variations in the parameters known to influence soil erosion by water. This includes accounting for variations in rainfall and runoff, the energy sources, on a storm-by-storm basis. Also to be considered are the distribution of watershed topography, soils, tillage practices, and vegetation which influence the degree of erosion or deposition. These factors are discussed with regard to simulation of the erosion-deposition continuum on agricultural watersheds.

75:02E-003
ON THE IMPOSSIBILITY OF A PARTIAL MASS VIOLATION IN SURFACE RUNOFF SYSTEMS,
Diskin, M.H.; Boneh, A.; and Golan, A.
Technion-Israel Institute of Technology, Haifa. Faculty of Civil Engineering.
Water Resources Research, Vol. 11, No. 2, p 236-244, April 1975. 6 fig, 9 ref.

Descriptors: *Surface runoff, *Systems analysis, *Rainfall-runoff relationships, Hydrographs, Hydrologic cycle, Hydrology, Flood flow, Hydrologic systems, Input-output analysis, Optimization, Theoretical analysis, Model studies.

The class of nonnegative, initially relaxed, and nonanticipating systems has many applications in engineering. A proof was given to a theorem stating that in this class of systems, if the input total mass is equal to the output total mass, then for any nonnegative input-output pair, the system fulfills also a partial mass condition. By applying this theorem to systems expressed by the Volterra series it was concluded that the input functions must be bounded. Two such bounds on the input functions were considered: (1) bounds resulting from the requirement of a nonnegative output and (2) bounds resulting from the mass-conserving property of the system. The theorem mentioned above implies that the set of input functions causing nonnegative output functions is a subset of the set of input functions that do not violate the mass-conserving property of the system. It is therefore clear that the bounds of type 1 are the dominant among the two bounds for any nonnegative input function. In a system expressed by an Nth order Volterra series the bounds on the input can be evaluated by solving a polynomial inequality of order N - 1. An example was given for a system expressed by a third-order Volterra series in which the bounds on the input form two ravines. Explicit equations for the bounds of type 1 and 2 were derived for a second-order system.

75:02B-004
SAMPLING PROCEDURES FOR NITROGEN AND PHOSPHORUS IN RUNOFF,
Burwell, R.E.; Schuman, G.E.; Piest, R.F.; Larson, W.E.; Alberts, E.E.
United States Department of Agriculture, Columbia, MO
Transactions of the American Society of Agricultural Engineers, Vol. 18 No. 5,
p 912-917, September-October 1975. 3 fig, 5 tab, 10 ref.

The nitrogen and phosphorus content of surface runoff from two watersheds in southwestern Iowa was analyzed for a 5-year period (1969-1973). Sampling procedures were evaluated for quantifying discharges of water-soluble NO3-N, NH4-N, and inorganic P and sediment-associated Kjeldahl N and NaHCO3-extractable P. The arithmetic mean nutrient concentration of samples collected during major runoff multiplied by the quantity of water or sediment discharged, compared favorably with a standard integration procedure for determining N and P discharges associated with surface runoff. Also, the arithmetic mean nutrient concentration of three samples collected during major runoff was adequate for determining storm discharges of water-soluble NO3-N and NH4-N and of Kjeldahl N associated with sediment. Nitrate-nitrogen concentrations showed a progressive decrease from storm to storm, indicating that each storm made for this decrease to determine the storm quantity discharges of NO3-N during the cropping season. This storm-to-storm effect was not as evident for NH4-N inorganic P, total Kjeldahl N, and NaHCO3-extractable P, indicating that sampling of every event would not be required to determine cropping season quantity discharges of these nutrient constituents.

Section VI

WATER CYCLE

GROUNDWATER (GROUP 02F)

75:02F-001
A SURROGATE-PARAMETER APPROACH TO MODELING GROUNDWATER BASINS,
Labadie, J.W.
Colorado State University, Fort Collins, Department of Civil Engineering
Water Resources Bulletin, Vol. 11, No. 1, p 97-114, February 1975. 5 fig, 13 ref.

Descriptors: *Parametric hydrology, *Mathematical models, *Groundwater basins, Hydrogeology, Least squares method, Model studies.

A surrogate-parameter approach to modeling groundwater basins was presented, which has the following advantages over current simulation-type methods: (1) conduciveness to modeling nonhomogeneous and nonisotropic basins; (2) there is no need to guess boundary conditions if accurate information is not available; (3) the model is amenable to systematic calibration or identification through the use of optimization techniques; and (4) compatibility with systematic algorithms for analyzing a wide range of management strategies. Since the parameter identification problem is large-scale and nonconvex, it was decomposed through application of generalized duality theory into several sub-problems of smaller size which were solved independently a number of times in order to achieve an overall solution. Results were presented for a hypothetical system of four interacting wells.

75:02F-002
TRANSFER OF BORON AND TRITIATED WATER THROUGH SANDSTONE,
Wierenga, P.J., van Genuchten, M.T., Boyle, F.W.
New Mexico State University, Las Cruces, Department of Agronomy
Journal of Environmental Quality, Vol. 4, No. 1, p 83-87, January-March 1975.
4 fig, 1 tab, 25 ref.

Descriptors: *Sandstones, *Boron, *Dispersion, *Groundwater, *Water quality, Groundwater recharge, Groundwater basins.

The movement of tritiated water and boron were determined during unsaturated flow through undisturbed sandstone cores. From the displacement and slope of the breakthrough curves relative to 1 pore volume of effluent, adsorption coefficients and dispersion coefficients were calculated of 0.115 and 1.08 cm(2)/day for boron, and 0.04 and 1.45 cm(2)/day for tritiated water, respectively. The data were used to predict the downward movement of boron through a sandstone formation in the Four Corners area of New Mexico. With 20 cm annual rainfall and 10% of the precipitation contributing to recharge, it was calculated to take 1,628 years for the boron concentration at the soil surface.

75:02F-003
ANALYSIS OF PUMPING TEST DATA FROM ANISOTROPIC UNCONFINED AQUIFERS CONSIDERING DELAYED GRAVITY RESPONSE,
Neuman, S.P.
Agricultural Research Organization, Bet Dagan (Israel). Institute of Soils and Water.
Water Resources Research, Vol. 11, No. 2, p 329-342, April 1975. 9 fig, 2 tab, 23 ref.

Descriptors: *Groundwater, *Aquifers, *Aquifer characteristics, *Aquifer testing, *Mathematical studies, Pump testing, Testing, Drawdown, Specific yield, Water wells, Unsteady flow, Equations, Anisotropy, Analysis, Observation wells.

A new analytical model was proposed for the delayed response process characterizing flow to a well in an unconfined aquifer. The new approach was based only on well-defined physical parameters of the aquifer system. As such, it can be used to develop methods for determining the hydraulic properties of anisotropic unconfined aquifers from field drawdown data. Two methods of analysis were described, one based on the matching of field data with theoretical type curves and the other based on the semi-logarithmic relationship between drawdown and time. These methods were illustrated by applying them to field pumping tests. Similar procedures can be used to analyze data from partially penetrating wells, but this requires that a special set of theoretical curves be developed for each field situation. Such theoretical curves can easily be developed with the aid of a computer program. An explicit mathematical relationship was derived between Boulton's delay index and the physical characteristics of the aquifer. It was shown that contrary to the assumption of Boulton the delay index is not a characteristic constant of the aquifer but decreases linearly with the logarithm of the radial distance from the pumping well. This discovery makes it possible to reinterpret the results of pumping tests that were previously obtained with the aid of Boulton's theory without necessarily reexamining the original drawdown data. Results from pumping tests were used to illustrate this last point.

75:02F-004
A STOCHASTIC MODEL OF DISPERSION IN A POROUS MEDIUM,
Todorovic, P.
Ecole Polytechnique, Montreal (Quebec).
Water Resources Research, Vol. 11, No. 2, p 348-354, April 1975. 4 fig, 10 ref.

Descriptors: *Stochastic processes, *Dispersion, *Porous media, *Groundwater, Equations, Mathematical studies, Diffusion, Groundwater movement, Diffusivity, Statistical methods, Saturated flow, Mass transfer, Model studies, Hydraulics, Probability.

A set of tagged particles released in a flow through a porous medium is subject to random dispersion. For a statistically homogeneous and isotropic porous medium a stochastic model of longitudinal dispersion was determined, provided the fluid flow was steady and no mass transfer occurs between the solid phase and the fluid. A stochastic model was presented to describe longitudinal dispersion of a set of tagged particles released continuously (but not necessarily at uniform rate) in a flow through a porous structure. The model depends on two constant parameters which in turn depend on the properties of the porous medium and hydraulic conditions. It was emphasized that the model presented was kinematic in the sense that it treated only the statistical properties of the law of motion of a tagged particle in a flow through a porous medium and did not go into particulars of dynamic conditions. Consequently, it did not explicitly contain parameters of the hydraulic forces leading to this motion.

75:02F-005
EFFECT OF SOLUTE DISPERSION ON THERMAL CONVECTION IN A POROUS MEDIUM LAYER, 2,
Rubin, H.
Technion-Israel Institute of Technology, Haifa. Faculty of Civil Engineering.
Water resources Research, Vol. 11, No. 1, p 154-158, February 1975. 4 fig, 8 ref.

Descriptors: *Solutes, *Dispersion, *Convection, *Temperature, *Porous media, Heat transfer, Mathematical models, Boundaries(Surfaces), Equations, Currents (Water), Groundwater movement, Aquifers, Stratification, Salinity.

In some situations associated with geothermal activity, groundwater motions are affected by convection currents due to large temperature gradients. In such cases, usually saline hot water is located in the deep layers of the aquifer from which salt and heat are transferred to the upper layers. In part 1 of this study the parameters of the two-dimensional flow field stability were determined. In part 2, further analysis of the phenomenon in three dimensions was presented. It was found that the convection cells have the shape of rolls whose axes are perpendicular to the steady state flow velocity. However, there is also a possibility of overstability of the flow field caused by rolls whose axes are parallel to the steady state velocity. The parameters of these two kinds of instability were determined.

75:02F-006
SUBSURFACE FLOW FROM SNOWMELT TRACED BY TRITIUM,
Martinec, J.
Swiss Federal Institute for Snow and Avalanche Research, Davos-Weissfluhjoch.
Water Resources Research, Vol. 11, No. 3, p 496-498, June 1975. 1 fig, 8 ref.

Descriptors: *Subsurface runoff, *Melt water, *Tritium, *Tracers, Groundwater movement, Snow, Runoff, On-site investigations, Infiltration, Discharge(Water), Hydrograph analysis, Lysimeters, Dispersion, Velocity, Radioisotopes, Recession curves.

An explanation was offered of the apparent discrepancy between the small velocities of subsurface flow and the watershed response. Environmental tritium in the hydrological cycle provided evidence for a new insight into the runoff mechanism. By this concept the quick reaction of outflow to a massive groundwater recharge was brought to agreement with the long residence time of the infiltrated water.

75:02F-007
IDENTIFICATION OF PARAMETERS IN A LINEAR EQUATION OF GROUNDWATER FLOW,
Nutbrown, D.A.
Department of the Environment, Reading (England). Central Water Planning Unit.
Water Resources Research, Vol. 11, No. 4, p 581-588, August, 1975. 12 fig, 5 ref, 1 append.

Descriptors: *Groundwater movement, *Hydrologic data, *Systems analysis, *Computer models, *Aquifer systems, Base flow, Model studies, Mathematical studies, Linear programming, Mathematical models, Finite element analysis, Analytical techniques, Transmissivity, Aquifer characteristics, Aquifers, Inflow, Groundwater recharge, Withdrawal.

An inductive method is presented for evaluation parameters in a two-dimensional linear equation describing groundwater flow. The approach employs finite difference approximations, which can be simply programmed for calculation by computer. Before illustrating the method, which is applicable to both stationary and time-dependent problems, the various types of data required for evaluation in general are systematically enumerated. An assumption is introduced limiting the local variability of T, the transmissivity, and its relation to apparently similar assumptions used elsewhere is discussed. The particular aquifer chosen for illustration is the chalk of the South Downs between the rivers Adur and Ouse. The parameters are calculated on the basis of cyclic data in which annual abstraction is about 10% of the total infiltration for the year. The method gives a match to the minimum and maximum water levels during the year to within 7%.

75:02F-008
CARBON 14 DATING OF GROUNDWATER FROM CLOSED AND OPEN SYSTEMS,
Wigley, T.M.L.
Waterloo University (Ontario). Department of Mechanical Engineering.
Water Resources Research, Vol. 11, No. 2, p 324-328, April 1975. 2 fig, 1 tab, 14 ref.

Descriptors: *Isotope studies, *Carbon radioisotopes, *Radioactive dating, Groundwater recharge, Stable isotopes, Isotope fractionation, Geochemistry, Temperature, Aquifer systems, Hydrogeology, *Florida, Groundwater, Aquifers.

Groundwaters may be dated by using carbon 14, provided that the raw data are
properly adjusted. However, adjustment factors determined from geochemical or
isotopic measurements and based on simple models of carbonate dissolution do not
always agree with adjustment factors obtained by independent means. Established
adjustment methods were reinterpreted in terms of closed and open system models
of carbonate dissolution, and it was suggested that these models provide a soun-
der framework for determining adjustment factors. Hypothetical and real ex-
amples were considered, and it was shown that some otherwise anomalous results
may be explained in terms of the closed and open system models.

75:02F-009
GROUND-WATER RECHARGE SIMULATION,
Amar, A.C.
New South Wales University, Duntroon, Australia, Faculty of Military Studies.
Journal of the Hydraulics Division, Vol. 101, No. HY9 p 1235-1247, September
1975. 6 fig, 17 ref, 2 append.

Descriptors: *Ground water recharge, *Simulation analysis, Aquifers, Groundwater
basins, Groundwater movement.

The purpose of this paper is to investigate the two-dimensional hydrodynamic be-
havior of recharge of an unconfined aquifer based on the potential theory formu-
latio. As is well known, the basic mathematical equation, according to poten-
tial theory for flow through porous media, is Laplace's equation in combination
with the time-dependent nonlinear boundary conditions on the curvilinear moving
free surface for which there is no known general analytical solution at present
(1975). The solution of this equation by a computational technique based on the
Accelerated Liebman Method is the primary objective of this paper. It will be
assumed that the flow is unsteady and the aquifer medium is saturated, homogene-
ous, and isotropic.

75:02F-010
A DIRECT METHOD FOR THE IDENTIFICATION OF THE PARAMETERS OF DYNAMIC NONHOMO-
GENEOUS AQUIFERS,
Nagar, B., Yakowitz, S., Duckstein, L.
Punjab Agricultural University, Ludhiana, Punjab, India, Department of Civil
Engineering.
Water Resources Research, Vol. 11 No. 4, p 561-570, August 1975. 1 fig, 1 tab,
11 ref.

Descriptors: *Aquifer characteristics, *Aquifers, Aquifer testing, *Transmissi-
vity, Groundwater, Groundwater movement, Model studies.

The investigation reported in this paper deals with a new direct method for iden-
tifying the parameters of a regional aquifer mode. The estimation of flow pro-
perties (such as the coefficient of transmissivity, heat conduction, or disper-
sion) of the aquifer is one of the critical problems for the management of ground-
water resources or conjunction management of groundwater and surface water. The
example of a simulated isotropic nonhomogeneous aquifer is used to illustrate
how the algebraic method recovers the transmissivity coefficient.

75:02F-011
BI-LEVEL SUBSURFACE DRAINAGE THEORY,
DeBoer, D.W.; Chu, S.T.
South Dakota State University, Brookings, Agricultural Engineering Department.
Transactions of the American Society of Agricultural Engineers, Vol. 18 No. 4,
p 665-667, July-August 1975. 4 fig, 5 ref.

Descriptors: *Drainage, *Drainage design, *Drains, Soil water movement, Irrigation effects, Drainage practices.

Drain line depths and spacings are generally greater for irrigated lands in the arid and semi-arid parts of the United States than for lands in the humid region. The average Oahe Unit drain line depth and spacing are estimated to be 2.7 m(9 ft) and 240m (790 ft), respectively. Cuts of 2.7 m require installation procedures which include the construction of a trench. Recently developed equipment that can successfully "plow-in" flexible drain tubing to a depth of 1.8 m (6 ft) has the potential to reduce subsurface drainage costs of the Oahe Unit even though the average drain depths are greater than the maximum installation depths of the present equipment. This can be accomplished by using the normal deep drain lines on an alternating basis with shallower drain lines. Since the drain lines are at two different elevations or levels in the drainage system, the terminology "bi-level drainage" seems appropriate. The objective of this paper is to develop analytical procedures to determine the maximum height of bi-level drainage water tables for steady state and falling water table cases.

75:03F-012
WATER FLOW THROUGH A MULTILAYER STRATIFIED HILLSIDE,
Selim, H.M.
Florida University, Gainesville. Department of Soil Science.
Water Resources Research, Vol. 11, No. 6, p 949-957, December 1975. 13 fig, 3 tab, 11 ref.

Descriptors: *Groundwater movement, *Stratification, *Mathematical models, Equations, Aquifers, Beds, Hydraulic conductivity, Saturated flow, Groundwater potential, Boundary layers, Depth, Ponds, Flow nets, Seepage, Flow rates, Potentiometric level, Subsurface runoff, Slopes.

The objective of this study was to present a mathematical analysis for steady state saturated flow through multilayer stratified hillsides of semi-infinite depth. Two soil surface shapes were considered: a constant soil surface slope and a surface of arbitrary shape. Potential and stream functions were obtained for one-, two-, and three-layered hillsides. The method of solution was based on the Gram-Schmidt orthonormalization method. For two-layered hillsides the hydraulic conductivities considered were K sub 1: K sub 2 = 1:10 and 10:1. For three-layered hillsides the hydraulic conductivities were K sub 1 : K sub 2 : K sub 3 = 1:10:1 and 10:1:10. Flow nets, seepage velocities, and flow rates were presented. These results were useful particularly with regard to subsurface flow, runoff, erosion, and solute movement through sloping soils.

75:03F-013
A HELE-SHAW MODEL STUDY OF STEADY STATE FLOW IN AN UNCONFINED AQUIFER RESTING ON A SLOPING BED,
Jaiswal, C.S., Chauhan, H.S.
Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (India). Department of Agricultural Engineering.
Water Resources Research, Vol. 11, No. 4, p 595-600, August 1975. 4 fig, 1 tab, 7 ref.

Descriptors: *Model studies, *Groundwater movement, *Slopes, *Seepage, Aquifers, Aquicludes, Water table aquifers, Equations, Height, Groundwater, Viscosity, Theoretical analysis, Steady flow.

Experiments were conducted on a vertical Hele-Shaw model to study the effect of slope of an impermeable layer on flow profiles and flow rates in an unconfined aquifer. Experimental results were compared with the solutions of Pavlovsky (1930) and Childs (1971) for nonuniform seepage on a small sloping impermeable bed. These studies showed that the solution of Pavlovsky may be used for the prediction of the flow profile downslope up to 30% slope and upslope up to 15% slope. Pavlovsky's equations also predicted flow rates and normal depths satisfactorily up to 30% slope. Child's equations also predicted similar results. None of these equations predicted the flow rate on negative slope satisfactorily.

75:02F-014
AQUIFER PARAMETER IDENTIFICATION,
Yeh, W.W-G.
California University, Los Angeles. Department of Engineering Systems.
Journal of the Hydraulics Division, Proceedings of American Society of Civil Engineers, Vol. 101, No. HY9, Paper 11592, p 1197-1209, September 1975. 2 fig, 1 tab, 27 ref, 2 append.

Descriptors: *Groundwater, *Aquifer characteristics, *Numerical analysis, *Unsteady flow, Aquifers, Optimization, Mathematical studies, Hydraulics, Equations, Subsurface water, Transmissivity, Mathematics, Linear programming, Analytical techniques, Diffusion, Diffusivity.

An analysis of the inverse problem of parameter identification in unsteady groundwater flow was presented. The response of the system is governed by a typical nonlinear second - order partial differential equation for which there exists no closed-form solution. Identification is an inverse process whereby the parameters embedded in a differential equation are determined from observations of the system's input and output along with appropriate initial and boundary conditions. These parameters are usually not physically measurable. A simple but illustrative inverse problem was analyzed by quasilinearization, maximum principle, gradient method, the influence coefficient method, and linear programming. A comparison was made between these methods. The problem of convergence and stability was examined and demonstrated by numerical experimentation.

75:02F-015
A HELE-SHAW ANALOG STUDY OF THE SEEPAGE OF GROUNDWATER RESTING ON A SLOPING BED,
Marei, S.M., Towner, G.D.
Cambridge University, (England). Department of Applied Biology.
Water Resources Research, Vol. 11, No. 4, p 589-594, August 1975. 5 fig, 8 ref.

Descriptors: *Model studies, *Seepage, *Groundwater, *Slopes, Aquifers, Groundwater movement, Aquicludes, Dupuit-Forchheimer theory, Water table aquifers, Equations, Height, Ditches, Discharge(Water), Viscosity.

The analysis derived from an application of the Dupuit-Forchheimer approximations by Childs to the problem of flow of groundwater over sloping impermeable beds, in which it is assumed that the streamlines are parallel to the sloping bed rather than horizontal as previously assumed by Pavlovsky, was tested in a Hele-Shaw analog. Seepage rates and water table positions were measured for a range of slopes up to 30 degrees and with flow both up and down the slope. Considerably better agreement was found, especially at the largest slopes, by using the revised assumption. The theoretical seepage rates calculated from Childs' analysis also lay between the limits given by an exact analysis due to Youngs, in contrast to values calculated by using Pavlovsky's analysis which fell outside the limits for large flow rates.

75:02F-016
A STOCHASTIC-CONCEPTUAL ANALYSIS OF ONE-DIMENSIONAL GROUNDWATER FLOW IN NONUNIFORM HOMOGENEOUS MEDIA,

Freeze, R.A.
British Columbia University, Vancouver. Department of Geological Sciences.
Water Resources Research, Vol. 11, No. 5, p 725-741, October 1975. 19 fig, 1 tab, 37 ref.

Descriptors: *Stochastic processes, *Groundwater movement, *Non-uniform flow, *Statistical models, Homogeneity, Porous media, Monte Carlo method, Saturated flow, Parametric hydrology, Hydraulic conductivity, Compressibility, Porosity, Distribution patterns, Spatial distribution, Aquifer characteristics, Correlation analysis, Aquifers, Consolidation, Steady flow, Unsteady flow.

The most realistic representation of a naturally occurring porous medium is a stochastic set of macroscopic elements in which the values of the three basic parameters (hydraulic conductivity, compressibility, and porosity) are defined by frequency distribution. All soils and geologic formations show random variations in the values of these parameters through space, and a measure of the nonuniformity is provided by the standard deviation of the frequency distributions. The analysis of groundwater flow in nonuniform media requires a stochastic-conceptual approach in which the effects of stochastic parameter distributions on predicted hydraulic heads are analysed with the aid of a set of Monte Carlo solutions to the pertinent boundary value problems. In this study, two one-dimensional saturated flow problems were analysed: steady state flow between two specified heads and transient consolidation of a clay layer. The primary output was the statistical distribution of hydraulic head. Results showed that the standard deviations of the input hydrogeologic parameters are important index properties. For transient flow, the output distribution of hydraulic head values is almost never normal. The results of the study questioned the validity of the underlying assumption of deterministic groundwater modelling that a single value for each flow parameter can define an 'equivalent' uniform porous medium.

75:02F-017
THE GALERKIN METHOD FOR NONLINEAR PARABOLIC EQUATIONS OF UNSTEADY GROUNDWATER FLOW,
Yoon, Y.S., Yeh, W.W-G.
California University, Los Angeles. Department of Engineering Systems.
Water Resources Research, Vol. 11, No. 5, p 751-754, October 1975. 2 fig, 15 ref.

Descriptors: *Unsteady flow, *Equations, *Groundwater movement, *Finite element analysis, Analytical techniques, Numerical analysis, Mathematical studies, Aquifers, Surface-groundwater relationships, Homogeneity, Isotropy, Water table, Specific yield, Hydraulic conductivity.

A relatively simple way was suggested for solving nonlinear parabolic partial differential equations associated with unsteady groundwater flow. The Galerkin formulation was discretized in the space domain by using piecewise polynomial equations, and the trapezoidal formula was employed to approximate the time derivative. The resulting system of nonlinear equations was then solved by the Newton method. Rapid rate of convergence and easy computer implementation were demonstrated by numerical examples. Results compared favorably with published experimental data.

75:02F-018
COUPLED SATURATED-UNSATURATED TRANSIENT FLOW IN POROUS MEDIA: EXPERIMENTAL AND NUMERIC MODEL,
Luthin, J.N., Orhun, A., Taylor, G.S.
California University, Davis. Department of Water Science and Engineering.
Water Resources Research, Vol. 11, No. 6, p 973-978, December 1975. 9 fig, 1 tab, 9 ref.

Descriptors: *Porous media, *Model studies, *Free surfaces, *Unsaturated flow, *Unsteady flow, Numerical analysis, Analytical techniques, Flow nets, Groundwater, Groundwater movement, Water wells, Potential flow, Moisture content, Computer models, Dupuit-Forchheimer theory, Finite element analysis.

Experimental data were obtained from a sector tank for the transient flow toward a well. The data included both the saturated and the unsaturated flow region. The data were used to verify the accuracy of a computer solution using an implicit numerical procedure. Agreement between the two sets of data was good. The computer solution can be adapted to a wide variety of groundwater flow problems.

75:02F-019
DETERMINING AQUIFER COEFFICIENTS FROM RESIDUAL DRAWDOWN DATA,
Vanden Berg, A.
Department of the Environment, Ottawa (Ontario). Inland Waters Directorate.
Water Resources Research, Vol. 11, No. 6, p 1025-1028, December 1975. 3 fig, 1 tab, 4 ref.

Descriptors: *Aquifer characteristics, *Transmissivity, *Storage coefficient, *Least squares method, *Drawdown, Hydraulics, Aquifers, Groundwater, Permeability, Porous media, Mathematical studies, Theis equation, Numerical analysis.

Hatush's equation for the drawdown in a leaky, infinite aquifer, adapted to the residual drawdown, was used to obtain a least sum of squares fit to the residual drawdown measurements in an observation well by iteratively adjusting the transmissivity, storativity, and leakage factor. First estimates for the least squares method were obtained by first fitting the equation, with a fixed high value of the leakage factor, to two points of the data; this was followed by a number of fits to three points, each fit yielding a set of values for the three aquifer coefficients; the set which yielded the least sum of squares was selected as first estimate to the main routine. An application to data from a pump test at Chatham, New Brunswick, was shown as an example.

75:02F-020
AN IDENTIFICATION APPROACH TO SUBSURFACE HYDROLOGICAL SYSTEMS,
Distefano, N., Rath, A.
California University, Berkeley. Department of Civil Engineering.
Water Resources Research, Vol. 11, No. 6, p 1005-1012, December 1975. 10 fig, 1 tab, 36 ref.

Descriptors: *Mathematical models, *Aquifer characteristics, *Transmissivity, Model studies, Subsurface waters, Aquifers, Groundwater, Mathematical studies, Observation wells, Hydrographs.

A method for the optimal determination of the transmissivity function in a model of a horizontal two-dimensional saturated aquifer, using time histories of the heads at a number of observation points, was developed. In this method the transmissivity function was assumed to be represented by a continuous spline surface over the entire domain of the aquifer and was given in terms of unknown nodal values disposed over a rectangular grid. These nodal values were then determined by requirements of optimality, i.e., by minimization of an error functional denoting the deviations of the observed and predicted heads at several strategically distributed observation wells. The method was complemented by using a hierarchical identification approach which consists of gradually increasing the number of nodal values employed in the analytical representation of the transmissivity function. Finally, a numerical example involving the determination of the transmissivity map of an aquifer by employing simulated head histories was presented to illustrate the feasibility of the proposed method.

75:02F-021
FORECASTING WATER LEVELS IN AQUIFERS BY NUMERICAL AND SEMIHYBRID METHODS,
Hefez, E., Shamir, U., Bear, J.
Technion-Israel Institute of Technology, Haifa. Department of Civil Engineering.
Water Resources Research, Vol. 11, No. 6, p 988-992, December 1975. 3 fig, 1 tab, 11 ref.

Descriptors: *Forecasting, *Water levels, *Aquifers, *Numerical analysis, *Hybrid computers, Model studies, Computer models, Resistance networks, Equations, Boundaries(Surfaces), Artesian heads, Transmissivity, Recharge, Water wells, Analog models.

Two methods which employ a cell model for forecasting water levels in aquifers were compared: the (noniterative) alternating direction implicit (ADI) finite difference method and a semihybrid iterative method, in which a resistor network is the analog part. By using simulation of the semihybrid method it was concluded that this method requires a larger computational effort than the ADI method.

75:02F-022
IDENTIFYING THE PARAMETERS OF AN AQUIFER CELL MODEL,
Hefez, E., Shamir, U., Bear, J.
Technion-Israel Institute of Technology, Haifa. Department of Civil Engineering.
Water Resources Research, Vol. 11, No. 6, p 993-1004, December 1975. 6 fig, 6 tab, 53 equ, 15 ref.

Descriptors: *Aquifers, *Parametric hydrology, *Hydrologic data, *Forecasting, Water levels, Groundwater, Transmissivity, Linear programming, Optimization, Equations, Mathematical models, Systems analysis, Constraints.

Cell models are commonly used for forecasting water levels in aquifers. Calibration of such models is achieved through identification of their parameter values, the transmissivities and storativities of all cells, using historical data. Several methods of formulating the identification as a linear or quadratic programming problem are presented. The aquifer is represented by a finite difference model. The proposed methods have been tested on synthetic models, the parameters of which were a priori known. Examples are given, results of the various methods compared, and the sensitivity of these results to errors in the data is discussed. Inflows or outflows during historical periods may also be determined by the same methods; an example for a real aquifer is presented.

75:02F-023
THE EFFECT OF CLIMATE ON THE CHEMISTRY OF CARBONATE GROUNDWATER,
Drake, J.J., Wigley, T.M.L.
McGill University, Montreal (Quebec). Department of Geography.
Water Resources Research, Vol. 11, No. 6, p 958-962, December 1975. 1 fig, 35 ref.

Descriptors: *Geochemistry, *Carbon dioxide, *Carbonates, *Aquifer characteristics, *Climates, *Model studies, Temperature, Chemistry, Carbonate rocks, Dolomite, Limestones, Calcite, Bicarbonates, Groundwater, Soil water, Soil chemistry, Water chemistry, Water quality, Subsurface waters, Erosion rates, North America.

The temperature coefficient of the log P sub CO2-temperature relationship for springwater from carbonate terrains in North America is approximately 0.07/C. Consideration of a simple model of soil air behavior and various published data suggested that the temperature coefficient of the same relationship for soil air is of the order of 0.03/C. A model where the soil zone is the source of carbon dioxide for water entering a groundwater system and where the subsequent chemical evolution of the water occurs under closed system conditions was consistent with these relationships.

75:02F-024
NORMAL MODE ANALYSIS OF THE LINEAR EQUATION OF GROUNDWATER FLOW,
Nutbrown, D.A.
Department of the Environment, Reading (England). Central Water Planning Unit.
Water Resources Research, Vol. 11, No. 6, p 979-987, December 1975. 6 fig, 1 tab, 7 ref.

Descriptors: *Base flow, *Mathematics, *Numerical analysis, *Computer models, *Unsteady flow, Equations, Groundwater movement, Confined water, Diffusion, Theis equation, Model studies, Simulation analysis, Hydrology.

The study of groundwater flow, given equations of motion and boundary conditions which are mathematically linear, can be analysed by using a normal mode approach. For the fully continuous case the simplest example is the familiar double Fourier analysis. Analogous results exist for the semidiscrete case, in which only time is treated as a continuous variable, and a method can be given for computing normal modes whose corresponding recession factors lie within prescribed ranges. One application of this approach suggested an empirical form for the base flow component of a stream hydrograph. The fully discrete case was also treated and provided a convenient basis for the comparison of the more common approximations to the solution of the transient groundwater flow equation. In particular, it was shown why the study of model problems does not provide a useful guide to the accuracy of the alternating direction implicit method applied to more general situations.

75:02F-025
THE USE OF ENVIRONMENTAL TRITIUM TO ESTIMATE RECHARGE TO A SOUTH-AUSTRALIAN AQUIFER,
Allison, G.B., Hughes, M.W.
Commonwealth Scientific and Industrial Research Organisation, Glen Osmond (Australia). Div. of Soils.
Journal of Hydrology, Vol. 26, No. 3/4, p 245-254, August 1975. 4 fig, 1 tab, 7 ref.

Descriptors: *Tritium, *Groundwater recharge, *Australia, Groundwater movement, Aquifers, Hydrogeology, Soil moisture, Sinks, Hydraulic gradient, Model studies, Mathematical models, Equations, Dispersion, Potentiometric level, Irrigation, Correlation analysis, Pumping, Evapotranspiration.

The tritium concentration of groundwater samples has been used to estimate the amount of water moving laterally into an aquifer as well as the quantity of local recharge. A multicompartment model used to calculate the variation of tritium concentration within the aquifer predicts that the lateral input of water is 34,000,000 cu m/yr, while local recharge is 27 mm/yr. These results are compared with conventional hydrogeological estimates of 18,000,000 cu m/yr and 70 mm/yr, respectively.

75:02F-026
AQUIFER EVALUATION USING DEPOSITIONAL SYSTEMS: AN EXAMPLE IN NORTH-CENTRAL TEXAS,
Hall, W.D., Turk, L.J.
Dames and Moore, Boca Raton, Florida.
Ground Water, Vol. 13, No. 6, p 472-483, November-December, 1975. 15 fig, 3 tab.

Descriptors: *Hydraulic properties, *Deltas, *Water chemistry, Permeability, Aquifer characteristics, Hydrochemical properties, Ion exchange, *Texas, Groundwater movement, Deposition(Sediments).

Delineation of major depositional systems and their component facies within the Lower Cretaceous Hosston and Hensel Sandstone Formations provides a model for predicting the distribution and chemical composition of water in the aquifer. Two major depositional trends occur in both formations: (1) a dip-oriented meanderbelt fluvial system which supplied sediment to (2) a strike-oriented delta system in the east. The meanderbelt sandstone facies of the fluvial systems and the coastal barrier facies of the delta systems are capable of supplying greater amounts of ground water than the floodbasin, lagoon-marsh-embayment, or prodelta/shelf facies. Chemical analysis of ground water suggests correlation between the hydrochemical facies and depositional facies. Ground water is dominantly of the calcium-magnesium bicarbonate type in the fluvial systems. The chemical character of the water changes downdip to sodium sulfate and sodium bicarbonate types in the delta systems. The change in chemical equilibrium probably occurs as dolomite-rich waters from the fluvial facies percolate downdip and dissolve anhydrite or oxidize pyrite in lagoonal facies within the delta system. Calcium may be exchanged for sodium on the marine clays.

75:02F-027
OZONATION OF AMMONIA IN WASTEWATER,
Singer, P.C., Zilli, W.B.
North Carolina University, School of Public Health, Department of Environment Sciences and Engineering, Chapel Hill, N.C.
Water Research, Vol. 9, No. 2, p 127-134, February 1975. 5 fig, 4 equ, 1 tab, 10 ref.

Descriptors: *Waste water, *Ozone, *Ammonia, Waste water treatment, Phosphate.

An investigation of the effects of ozone on ammonia in municipal wastewaters is described and discussed relative to the application of ozone for advanced waste treatment. Ammonia is oxidized completely to nitrate, thereby eliminating the nitrogenous oxygen demand of the waste. In buffered solutions of ammonium chloride, the reaction is first-order with respect to the concentration of ammonia and the rate increases with increasing pH over the range 7-9, and with increasing ozone partial pressure.

75:02F-028
THE USE OF A SPECIALIZED DRILLING AND GROUND-WATER SAMPLING TECHNIQUE FOR DELINEATION OF HEXAVALENT CHROMIUM CONTAMINATION IN AN UNCONFINED AQUIFER, SOUTHERN NEW JERSEY COASTAL PLAIN,
Yare, B.S.
Woodward-Clyde Consultants, 1377 Broad Street, Clifton, New Jersey 07012.
Ground Water, Vol. 13, No. 2, p 151-154, March-April 1975. 4 fig, 1 tab, 5 ref.

Descriptors: *Chromium, *Water pollution, Groundwater, Water sampling, Water quality, Water quality control, New Jersey.

Consultants were retained to investigate a ground-water contamination problem caused by disposal of chromium-laden process water into an unlined lagoon in the Coastal Plain sediments of southern New Jersey. During the course of the investigation, a technique for sampling of formation water at specific horizons during drilling was developed. This technique consists of the following procedure: (1) drilling a borehole to the base of a sampling horizon; (2) lowering a wire-wound well screen and riser pipe to the bottom of the borehole and gravel-packing the screen; (3) pumping the borehole well until the discharge is clear of drilling fluid; and (4) pumping at least 100 gallons of formation water before collecting the sample and performing field water quality tests.

75:02F-029
EARTH RESISTIVITY SURVEYS - A METHOD FOR DEFINING GROUND-WATER CONTAMINATION,
Stollar, R.L., Roux, P.
Geraghty & Miller, Inc., 44 Sintsink Drive East, Port Washington, New York 11050.
Ground Water, Vol. 13, No. 2, p 145-150, March-April 1975, 4 fig, 16 ref.

Descriptors: *Groundwater, *Pollution, Groundwater resources, Water quality, Water quality control, Water pollution, Water sampling.

An important part of every investigation of ground-water pollution is to locate and define the extent of the contaminated body of ground water. The usual method for accomplishing this is to install and sample numerous test wells, a costly and time-consuming procedure. A much faster and less costly method, which has proven to give accurate results, is the earth resistivity survey. Because earth resistivity is inversely proportional to ground-water conductivity, the location of ground water that has been contaminated by a relatively high concentration of conductive industrial wastes, for example, may be quickly and accurately traced.

75:02F-030
THEORY OF GROUND-WATER RECHARGE FOR A STRIP BASIN,
Amar, A.C.
Faculty of Military Studies, University of New South Wales, Duntroon, A.C.T., 2600, Australia.

Ground Water, Vol. 13, No. 3, p 282-292, May-June 1975. 9 fig, 14 equ, 16 ref, 2 append.

Descriptors: *Model studies, *Groundwater, *Groundwater recharge, *Groundwater resources, *Dupuit-Forchheimer theory.

Formulation and solution of one-dimensional analytical and computational models, linear as well as nonlinear, pertaining to a typical ground-water recharge pattern are presented. The objective of this investigation is to direct attention toward an evaluation and correlation of the various theoretical models based on the Dupuit-Forchheimer (D-F) approximations for the unsteady hydrodynamic behavior of the proposed recharge system under saturated flow conditions. Comparisons with the pertinent experimental data, presented in the form of dimensionless graphs, indicate that the linear D-F theory is valid for relatively small water-table rises but for large rises it predicts substantially greater rises than actually occur, particularly beneath and in the vicinity of the recharge basin. The range of validity is considerably improved between theory and experiments for relatively large rises using the nonlinear theory.

75:02F-031
APPROXIMATION FOR STEADY INTERFACE BENEATH A WELL PUMPING FRESH WATER OVERLYING SALT WATER,
Haubold, R.G.
Colorado Division of Water Resources, Denver, Colorado 80203.
Ground Water, Vol. 13, No. 3, p 254-259, May-June 1975. 3 fig, 1 tab, 9 equ, 12 ref.

Descriptors: *Saline water, *Saline water intrusion, Saline water systems, Saline water-Freshwater interfaces, Mathematical studies, Aquifers, Groundwater.

A mathematical expression was developed which would approximate the steady position and shape of a sharp, upconed interface between fresh and salt water in an aquifer when the fresh water only is being pumped from a well. The computation of the interface shape was based on an empirically derived modification of Muskat's approximation for the height of the cone beneath a well. Differing depths of well penetrations and their effect on the upconed interface were investigated with the approximation. The computed interfaces were compared with corresponding interfaces determined experimentally in a Hele-Shaw model. Close agreements could be achieved for interfaces which penetrated as much as 50% of the distance between the bottom of the well and the initial interface position. Changing the length of the producing interval of the well while keeping its pumping rate constant did not have a significant influence on the shape or position of the upconed interface. Even though the shape and position of the upconed interface could be approximated, a refinement of the analytical methods used in deriving the approximation for the interface may be necessary before it can be applied reliably.

75:02F-032
ECONOMIC IMPACTS OF STATE ENVIRONMENTAL PROGRAMS IN A NATIONAL FRAMEWORK: THE IOWA CONSERVANCY LAW,
Heady, E.O., Nagadevara, V.S.S.V.
Iowa State University, Ames 50010.
Journal of Soil and Water Conservation, Vol. 30, No. 6, p 272-278, November-December, 1975. 3 fig, 5 tab, 8 ref.

Descriptors: *Legislation, *Iowa, *Sediments, *Erosion, Economics, Economic justification.

Several states have passed laws to protect prime farm land, reduce environmental impacts, or eliminate off-site sediment damages. The 1971 Iowa legislature, for example, passed the Conservancy District Act to control the use of soil and water resources and thereby limit annual soil loss. Because of the inelastic demands for farm commodities, one state such as Iowa may restrain land use with the result that its farmers sacrifice income while farmers elsewhere gain income. We applied national models to determine what the outcome would be if Iowa were to fully implement its Conservancy District Act or apply other environmental restraints, such as limiting nitrogen and pesticide use. The results show that in all cases restraints implemented solely in Iowa would reduce net farm income in the state while income elsewhere in the nation would increase. Hence, national as opposed to state legislation is implied for the long run.

75:02F-033
A SIMPLE CASE OF CONJUNCTIVE SURFACE-GROUND-WATER MANAGEMENT,
Morel-Seytoux, H.J.
Colorado State University, Fort Collins, Colorado 80521.
Ground Water, Vol. 13, No. 6, p 506-515, November-December 1975. 1 fig, 2 tab, 38 equ, 21 ref, 2 append.

Descriptors: *Model studies, *Hydrology, Hydrologic system, Groundwater resources, Groundwater basins, Legislation.

A specific hydrologic model of a stream-alluvial aquifer system was developed for the purpose of designing rules and regulations which maximize the beneficial uses of the waters of a State within the law. The model is particularly suited when decisions on pumping rates are to be reviewed on a frequent regular basis. The procedure is illustrated on a simplified case for which the river loss influence coefficients can be obtained by a combination of analytic derivations and algebraic manipulations.

75:02F-034
WATER ZONING - TOOL FOR GROUND-WATER BASIN MANAGERS,
Dutcher, L.C.; Peterson, L.R.
United States Geological Survey, Denver, Colorado 80225.
Ground Water, Vol. 13, No. 5, p 396-399, September-October 1975. 5 ref.

Descriptors: *Groundwater, *Groundwater availability, *Groundwater basins, *Groundwater resources, *Water zoning, Water conservation.

Water zoning is not new in arid areas. Many States have laws limiting pumping. However, most of the existing ordinances do not achieve their state purpose. Many enforce conservation of scarce resources for benefit of future users. Some purport to ensure a continuous water supply to the rights holders. Existing ordinances that limit pumping to the so-called safe yield do not take costs or recoverable benefits into consideration, and the period of use is not stipulated. Therefore where pumping is regulated under such ordinances, the basins cannot be managed to obtain maximum benefits to present users of the available supply. Two types of ordinances are discussed: general-purpose and management-plan ordinances, which are designed to make possible the achievement of specific objectives. Examples are given of how the latter can be designed to: limit stream depletion and protect existing rights; disperse pumping to increase economic return; force conjunctive use of all land, mineral, and water resources; and establish production quotas to insure optimum economic return to all users during a predetermined period.

75:02F-035
DIURNAL FLUCTUATIONS OF WATER TABLES INDUCED BY ATMOSPHERIC PRESSURE CHANGES,
Turk, L.J.
Texas University, Austin. Department of Geological Sciences.
Journal of Hydrology, Vol. 26, p 1-16, 1975. 8 fig, 17 ref.

Descriptors: *Water table, *Aquifers, *Utah, *Atmospheric pressure, Groundwater.

The shallow water table at the Bonneville Salt Flats, Utah, fluctuates 1.5-6.0 cm per day during the summer, and 0.5-1.0 cm per day during the winter. Highest water levels occur in late afternoon, whereas lowest levels occur in mid-morning. Similar fluctuations are attributed to temperature-related atmospheric pressure changes acting on the capillary zone. This proposed mechanism involves the transfer of water from below the water table to the capillary fringe in response to lower pressure, and transfer of water from the capillary fringe to the water table in response to higher pressure. Rapid volume changes of air entrapped in the capil- lary pores account for the expulsion or infusion of capillary water. Laboratory experiments with an artificial aquifer confirm that such fluctuations can occur rapidly when the only variable is pressure. In this case no intervening confining layer exists, so the mechanism is distinctly different from the mechanism which causes blowing wells.

75:02F-036
THE KINETICS OF MINERAL DISSOLUTION IN CARBONATE AQUIFERS AS A TOOL FOR HYDROLOGI-
CAL INVESTIGATIONS, I. CONCENTRATION-TIME RELATIONSHIPS,
Mercado, A., Billings, G.K.
New Mexico Institute of Mining and Technology, Socorro, N.M. Department of Geosci-
ence.
Journal of Hydrology, Vol. 24, p 303-331, 1975. 9 fig, 2 tab, 54 equ, 29 ref.

Descriptors: *Aquifers, Hydrologic systems, Hydrologic properties, Carbonates, Model studies, Groundwater, Water quality.

Groundwater chemical analyses, water level maps, and results of pumping tests are sufficient for studying the relationships between the major geochemical and hydro- logic processes in a groundwater system. The importance of available groundwater chemical data for hydrologic investigations has been relatively neglected. Two general courses exist for use of groundwater chemical data and dissolution kinetics in hydrologic investigations: (1) estimating relative ages according to precali- brated concentration-time relationships similar to that of tritium and 14C dating techniques; and (2) integrated study of both hydrologic and geochemical phenomena with the aid of combined hydrogeochemical models. In this paper, a kinetic model for the dissolution of multimineral assemblages in porous media is derived with special emphasis on the simultaneous dissolution of calcite, dolomite and gypsum in some carbonate aquifers.

75:02F-037
TRANSFORMATIONS OF FLUXES AND FORCES DESCRIBING THE SIMULTANEOUS TRANSPORT OF
WATER AND HEAT IN UNSATURATED POROUS MEDIA,
Raats, P.A.C.
Agricultural Research Service, Riverside, California.
Water Resources Research, Vol. 11, No. 6, p 938-942, December 1975. 18 ref.

Descriptors: *Subsurface flow, *Porous media, *Heat transfer, *Analytical tech- niques, *Groundwater, Unsaturated flow, Mathematical studies, Equations, Hydrother- mal studies, Temperature, Thermal water, Heat, Diffusivity.

Balances of mass for the water in n distinct phases and a balance of heat for the medium as a whole were formulated. Following Philip and de Vries, it was assumed that the flux of water in each phase is proportional to the gradient of the pressure in that phase and that the diffusive component of the flux of heat is pro- portional to the gradient of the temperature. Clapeyron equations were used to express the gradient of the pressure in any phase in terms of the gradient of the pressure in a reference state and of the temperature. The reference state may be the water in one of the phases or the water in some measuring device such as a tensiometer or a psychrometer. Expressions for the total flux of water and for the diffusive flux of heat plus the convective flux of heat associated with the conver- sion from any phase to the reference state were shown to satisfy the Onsager reciprocal relations. A theorem due to Meixner was used to delineate the class of fluxes and forces that preserves these relations. In particular, it was shown that if the gradients of water content and temperature are used as the driving forces, the Onsager relations are no longer satisfied.

75:02F-038
COMPARATIVE STUDY OF FRESH-SALT WATER INTERFACES USING FINITE ELEMENT AND SIMPLE
APPROACHES,
Kashef, A.A. I., Safar, M.M.

North Carolina State University, Raleigh, NC
Civil Engineering Department.
Water Resources Bulletin, Vol. 11, No. 4, p 651-665, August 1975. 3 fig, 4 tab, 28 equ, 15 ref, 1 append.

Descriptors: *Saline water-freshwater interfaces, Artesian aquifers, Aquifer management, Aquifer systems, Aquifers, Groundwater, Water resources, Water quality.

The fresh-salt water interface in artesian aquifers has been investigated by various techniques on the basis of its analogy to the free surface in earth dams or cores of dams. Although various approximations are used, some more or less exact solutions exist. One of the simple methods, that would appeal to practical workers, was developed by the analysis of hydraulic forces. However, this method has not been checked thoroughly due to the lack of wide ranges of coverage by the more or less exact solutions. In this paper a suggested finite element method is used for the purpose of comparing with the method of hydraulic forces. The presented procedure eliminates some of the difficulties and uncertainties in current finite element procedures. Both methods proved to be in close agreement. Moreover, the hydraulic heads along the upper boundary of the artesian aquifer were found to be in close agreement with Dupuit's equation. The results of this investigation would greatly simplify the more complex management problems when the effects of discharge and/or recharge wells are added to the natural flow effects.

Section VII

WATER CYCLE

WATER IN SOILS (GROUP 02G)

75:02G-001
SIMULATION OF MISCIBLE DISPLACEMENT IN SOILS USING THE METHOD OF CHARACTERISTICS,
Smajstrla, A.G., Reddell, D.L., Hiler, E.A.
Texas A and M University, Colage Station. Deparvment of Agricultural Engineering.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 2,
p 281-287, March-April 1975. 9 fig, 37 ref, 1 append.

Descriptors: *Simulation analysis, *Mathematical models, *Porous media, *Infiltration, *Soils, Computer programs, Model studies, Management, Darcys law, Dispersion, Saturated flow, Unsaturated flow, Solutes, Saturated soils, Moisture content, Homogeneity, Steady flow, Unsteady flow.

A simulation model was developed to simulate miscible displacement of a conservative solute during one-dimensional vertical infiltration into a homogeneous, isotropic, porous media. Solutions of transient flow problems were obtainable as well as steady state problems because it was not necessary to assume constant solution fluxes to solve the dispersion equation. The accuracy of the simulation results from the literature. Comparisons provided excellent agreement in all cases except for Warrick's field experimental data. Considering the nonhomogeneous field conditions encountered in Warrick's experimental plot, the simulated results were considered to be good.

75:02G-002
PLANNING IRRIGATION AND DRAINAGE SYSTEMS USING RETENTION AND EXTRACTION LIMITS,
Campbell, R.D., Lembke, W.D.
Bureau of Reclamation, Denver, Colorado.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 3,
p 514-517, May-June 1975. 8 fig, 15 ref.

Descriptors: *Irrigation, *Drainage, *Planning, Irrigation engineering, Drainage engineering, Model studies.

Rather than explaining that water held in the soil between field capacity and the wilting percentage is available for plant growth and then trying to define field capacity and wilting percentage to suit our needs, we choose to define two new range limits and show how use of these limits can provide for efficient use of water and maximum plant growth. We will use data reported by Denmead and Shaw (1962) and a model developed by Campbell (1972) to display the ideas associated with these limits.

75:02G-003
NITRATE REDUCTION AND ASSOCIATED MICROBIAL POPULATIONS IN A PONDED HANFORD SANDY LOAM,
Volz, M.G., Belser, L.W., Ardakani, M.S., McLaren, A.D.
California University, Berkeley, Department of Soils and Plant Nutrition
Journal of Environmental Quality, Vol. 4, No. 1, p 99-102, January-March 1975.
1 fig, 3 tab, 21 ref.

Descriptors: *Nitrate, *Denitrification, Soils, Soil investigations, Soil bacteria, Nitrite.

A field plot of Hanford sandy loam was ponded for 2 weeks with a solution of KNO3 and Ca (NO3)2 containing 100 ppm NO3-N in order to measure short term denitrification rates as well as growth and distribution of bacteria capable of reducing nitrate to nitrite and/or N2O and N2. Denitrifying bacteria generally decreased in number with depth and time and were not as numerous as nitrate reducers.

75:02G-004
AGRICULTURAL DRAINAGE RESEARCH NEEDS AND PRIORITIES, 1974
Carter, C.E., Donnan, W.W., King, L.D., Schwab, G.O.
Agricultural Research Service, United States Department of Agriculture, Baton Rouge, La.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 3, p 529-534, May-June 1975. 3 tab.

Descriptors: *Drainage, *Drainage engineering, *Research priorities, Agriculture.

Drainage research has played an important role in increasing food and fiber production in the United States. In the future its importance is expected to increase as farmers attempt to increase crop yield per acre to meet the increased demands for food and fiber both at home and abroad. Results of a survey made during 1973 to 1974 to determine drainage research needs in the United States is reported in this paper.

75:02G-005
A MATHEMATICAL MODEL FOR PHOSPHORUS MOVEMENT IN SOILS,
Shah, D.B., Coulman, G.A., Novak, L.T., Ellis, B.G.
Michigan State University, East Lansing, Department of Chemical Engineering.
Journal of Environmental Quality, Vol. 4, No. 1, p 87-92, January-March 1975. 3 Fig, 16 ref, 1 append.

Descriptors: *Model studies, *Phosphorus, Soil investigations, Soils, Soil properties, Waste disposal.

Land application of municipal and industrial wastes is increasingly being looked upon as an alternative for treatment of the effluent. Since phosphorus compounds constitute a major potential source of ground water contamination, it is important to study the movement of these compounds in the soil. In this paper, a model for the movement of P has been developed. Material balance equations for water in the soil pore spaces, P in the liquid phase, and adsorbed P on the soil have been formulated. These equations are solved numerically to simulate the P concentration profiles in the soil solution and in the soil as functions of depth for an operating waste disposal system. The results of the simulation show a good agreement with the field data. The model can be used to determine the response of the system for a given input of phosphates and thus is a useful tool in the design and management of such systems.

75:02G-006
PHOSPHORUS MOVEMENT IN SOILS: THEORETICAL ASPECTS,
Novak, L.T., Adriano, D.C., Coulman, G.A., Shah, D.B.
Cleveland State University, Cleveland, Ohio, Department of Chemical Engineering
Journal of Environmental Quality, Vol. 4, No. 1, p 93-99, January-March 1975. 8 Fig, 5 tab, 16 ref, 1 append.

Descriptors: *Waste water, *Model studies, *Phosphorus, *Soils, Soil investigations, Agriculture, Mathematical models.

The renovation of waste water by land application shows promise because of the potential to use certain waste water nutrients to fertilize agricultural crops and to recycle these nutrients as agricultural products. In order to locate, design, and manage land treatment processes, quantitative descriptions of critical processes are required. The adsorption of P by soils is a critical process which needs to be considered. This paper compares a new model for P movement in soils with existing adsorption-desorption models developed for chromatography and ion exchange processes. The effect of the model parameters on P movement in soils is also examined. From the new model considered here, it was found that under P adsorption, a P profile of fixed shape (shock layer) developed and moved through the soil at a speed which could be calculated from the P Langmuir adsorption isotherm, density of the soil, and the P rate of application to the soil.

75:020-007
DRAIN ENVELOPE RESPONSE TO FIELD TREATMENTS,
Willardson, L.S., Davis, S., Mulder, D., Spencer, J.R.
Imperial Valley Conservation Research Center, Brawley, CA
Transactions of the American Society of Agricultural Engineers, Vol. 18,
No. 1, p 134-136, January-February 1975. 6 Fig, 3 ref.

Descriptors: *Drains, *Drainage, *Drainage engineering, *Drainage systems.

One of the principal reasons for installing a drain envelope is to decrease hydraulic resistance in the vicinity of the drain openings. This experiment has shown that contamination of the envelope material with fine particles, whether naturally occurring or added during installation, causes the hydraulic conductivity of a drain envelope to decrease drastically. Furthermore, conditions are created which may result in a discharge rate decreasing with time. A drain with a clean, well-graded envelope will accept water without a water table build-up over the drain. A water table above a drain indicated a back pressure in the drain or a high hydraulic resistance in the envelope. In the experiment, the latter cause was the reason for poor drain envelope performance but both conditions should be avoided. The results of the experiment have led to the following conclusions: (a) As little as 5 percent of field soil in the envelope material seriously reduces drain envelope performance, (b) flooding trenches for consolidation of backfill material does not significantly affect drain envelope performance, and (c) high-pressure jet cleaning of drains improves hydraulic performance of drain envelopes.

75:020-008
SIMULTANEOUS TRANSPORT OF WATER AND ABSORBED SOLUTES THROUGH SOIL UNDER TRANSIENT FLOW CONDITIONS,
Davidson, J.M., Baker, D.R., Brusewitz, G.H.
Florida, Gainesville, Department of Soil Science
Transactions of the American Society of Agricultural Engineers, Vol. 18,
No. 3, p 535-539, May-June 1975. 4 fig, 34 ref.

Descriptors: *Simulation analysis, Soilwater movement, Soil investigations, *Solutes, Model studies.

A set of differential equations for water and interacting and noninteracting solute transport were solved simultaneously for transient and steady state soil water conditions using a finite difference scheme. The solutions used independently measured soil and soil-solute adsorption-desorption characteristics to describe the movement of a solute in a soil profile. Numerical dispersion in the finite difference solution of the solute transport equation was considered and a correction included in the solution. Experimental results from a laboratory study were used to test the numerical solution's ability to describe the movement and distribution of a herbicide in a soil profile with time. A natural field problem involving infiltration and evaporation was simulated and discussed. The agreement between laboratory and calculated water and herbicide distributions was good.

75:020-009
WATER INTAKE UNDER CENTER-PIVOTS FROM TIME-VARYING APPLICATION RATES,
Addink, J.W., Miles, D.L., Skogerboe, G.V.
Nebraska University, Lincoln, Department of Agricultural Engineering,
Transactions of the American Society of Agricultural Engineers, Vol. 18,
No. 3, p 523-525, May-June 1975. 4 fig, 3 tab, 14 ref.

Descriptors: *Model studies, *Sprinkler irrigation, Irrigation, Irrigation engineering, Infiltration, Infiltration rates.

Design considerations of center-pivot sprinkler systems are different than those for conventional systems. Stationary sprinkler system design is primarily concerned with uniformity of water application. Sprinklers are selected so that application rates do not exceed intake rates. One approach to water intake problems is numerical solution of moisture flow equations. One of the earlier published solutions considered horizontal and vertical flow from a constant surface saturation (Klute 1952). The techniques have become more sophisticated with time. Smith and Woolhiser (1971) included rainfall and ponded conditions and overland flow resulting from runoff. This paper presents results of runoff studies using the model of Smith and Woolhiser (1971) and laboratory studies.

75:02G-010
RATE OF CHLORIDE AND WATER MOVEMENT IN SOUTHERN CALIFORNIA SOILS.
Tullock, R.J., Coleman, N.T., Pratt, P.F.
California University, Riverside, Department of Soil Science and Agricultural Engineering.
Journal of Environmental Quality, Vol. 4, No. 1, p 127-131, January-March 1975. 3 Fig, 3 tab, 25 ref.

Descriptors: *Chlorides, *Soils, *Soil investigations, *Soil water movement, California, Columns.

Column experiments in the laboratory showed an increase of 2 to 35% in the relative rate of chloride movement in soils to water when the movement of water was calculated on a total pore-volume basis. The increase was explained as a result of anion exclusion next to the surfaces of negatively charged soil colloids. The relative rate of flow was decreased when the moisture retained by the air dry soils was deleted from the total pore solution. For soils containing sufficient clay to result in a cation exchange capacity greater than 10 meq/100g, an equation was developed relating the fraction of the pore solution in equilibrium with anions to the cation exchange capacity. Calculated transit times for anion movement from the soil surface to ground waters should include a correction for the volume of exclusion.

75:02G-011
OCCURRENCE OF 2,4,5-T and PICLORAM IN SUBSURFACE WATER IN THE BLACKLANDS OF TEXAS
Bovey, R.W., Burnett, E., Richardson, C., Baur, J.R., Merkle, M.G.
Journal of Environmental Quality, Vol. 4, No. 1, p 103-106, January-March 1975. 1 Fig, 7 tab, 13 ref.

Descriptors: *Herbicides, *Lysimeters, *Groundwater, Watershed(Basin), Water quality, Pollutants, Subsurface waters.

This investigation was conducted to determine the concentration of 2, 4, 5-T ((2,4,5-trichlorophenoxy) acetic acid) and picloram (4-amino-3,5,6-trichloropicolinic acid) in subsurface water after spray applications of the herbicides to the surface of a seepy area watershed and lysimeter in the Blacklands of Texas. A 1:1 mixture of the triethylamine salts of 2, 4, 5-T + picloram was sprayed at 2.24 kg/ha every 6 months on the same area for a total of five applications. Herbicide content in the Houston Black clay during the study ranged from 0 to 167 ppb. Herbicide content on grass was high immediately after spraying, but degraded rapidly after each treatment. Concentration of 2, 4, 5-T and picloram in seepage and well water from the treated area was extremely low (less than 1 ppb) during the 3-year study. No 2, 4, 5-T was detected from 122 drainage samples from a field lysimeter sampled for 1 year after treatment with 1.12 kg/ha of 2, 4, 5-T + picloram (1:1). Picloram was detected in small amounts (1 to 4 ppb) 2 to 5 months after treatment in lysimeter water.

75:02G-012
ESTIMATING INFILTRATION FOR ERRATIC RAINFALL,
Reeves, M., and Miller, E.E.
Oak Ridge National Laboratory, Tennessee.
Water Resources Research, Vol. 11, No. 1, p 102-110, February 1975. 14 fig,
1 tab, 11 ref, 2 append.

Descriptors: *Infiltration, *Rainfall intensity, *Soil water movement, *Mathematical models, *Estimating, Groundwater movement, *Rainfall-runoff relationships, Runoff, Seepage, Simulated rainfall, Soil water, Infiltration rates, Hysteresis, Soil physical properties, Precipitation intensity, Hydrology, Watersheds(Basins), Storms.

To cheaply estimate the infiltration/runoff of typically unsteady rainfall events for purposes of watershed modeling, a method known as 'time compression' was tested against hysteretic Darcy computations. This method assumes that for a given soil the maximum infiltration rate is simply a function of the cumulative infiltration, regardless of the rainfall versus time history. The appraisal proved generally encouraging for application of this approximation to watershed modeling. The maximum infiltration rate was uniformly underestimated to a moderate degree in the early minutes of a downpour commencing late in an unsteady event.

75:02G-013
A THERMODYNAMIC INTEGRAL EQUATION FOR THE EQUILIBRIUM MOISTURE PROFILE IN SWELLING SOIL,
Sposito, G.
Arizona Water Resources Research Center, Tucson.
Water Resources Research, Vol. 11, No. 3, p 499-500, June 1975. 10 ref.

Descriptors: *Soil moisture, *Thermodynamics, *Equilibrium, *Equations, Solutes, Profiles, Water table, Entropy, Temperature, Bulk Density, Porous media.

The methods of thermodynamics were employed to develop a nonlinear integral equation for the equilibrium moisture profile in a swelling soil which was assumed to be uniform in the distribution of dissolved substances. The equation was shown to be identical with an expression suggested (but not derived) by Philip in response to criticism of his discussion of the hydrostatics of swelling porous media.

75:02G-014
CONVERGENCE AND VALIDITY OF TIME EXPANSION SOLUTIONS: A COMPARISON TO EXACT AND APPROXIMATE SOLUTIONS,
Parlange, J-Y
Connecticut Agricultural Experiment Station, New Haven. Department of Ecology and Climatology.
Soil Science Society of America Proceedings, Vol. 39, No. 1, p 3-6, January-February 1975. 1 fig, 12 ref.

Descriptors: *Mathematical studies, *Equations, *Diffusion, Saturated flow, Saturated soils, Porous media, Infiltration, Diffusivity, Boundaries(Surfaces), Absorption.

The convergence of series solutions for the diffusion equation by time expansion was discussed quantitatively, on the basis of the linear and delta function solutions for a spherical cavity. It was shown that convergence alone is a poor criterion to justify the validity of the series solutions. A counter example, diffusion in the presence of an impervious wall, showed that the series may converge for all times but be entirely erroneous. By comparison, an approximate integral technique yields a solution which agrees very well with the exact result.

75:020-015
EFFECT OF APPLICATION RATE, INITIAL SOIL WETNESS, AND REDISTRIBUTION TIME ON SALT DISPLACEMENT BY WATER,
Ghuman, B.S., Verma, S.M., and Prihar, S.S.
Punjab Agricultural University, Ludhiana (India). Department of Soils.
Soil Science Society of America Proceedings, Vol. 39, No. 1, p 7-10, January-February 1975. 7 fig, 1 tab, 6 ref.

Descriptors: *Leaching, *Salts, *Soil moisture, *Infiltration, *Path of pollutants, Groundwater, Water pollution, Chlorides, Soil water movement, Percolation, Distribution patterns, Water distribution(Applied).

Certain concepts regarding the displacement and profile-spread of surface-salts with applied water and the leaching efficiency of applied water were experimentally verified with soil columns. Treatments included different amounts and rates of water application and different initial soil water contents. Salt and water profiles were determined by destructive sampling in 2-cm depth intervals after variable times of redistribution. Salt front coincided with the water front in the initially dry soil and lagged behind it in the initially moist soil. Salt peak immediately after infiltration and after redistribution, for all initial soil water contents, occurred at a depth above which total water storage equaled infiltration. But the salt spread in the profile increased as the initial water content increased. Immediately following infiltration, salt was displaced deeper with slower than with faster rates of water application. But when the application plus redistribution time was matched, the salt showed deeper movement with water added at faster than at slower rates. These results show that slower rates of water application may not increase the leaching efficiency of water under field conditions.

75:020-016
DETERMINATION OF SOIL WATER DIFFUSIVITY BY SORPTIVITY MEASUREMENTS,
Dirksen, C.
Agricultural Research Service, Riverside, California Salinity Lab.
Soil Science Society of America Proceedings, Vol. 39, No. 1, p 22-27, January-February 1975. 6 fig, 2 tab, 11 ref.

Descriptors: *Soil moisture, *Moisture content, *Diffusion, *Absorption, *Hydraulic conductivity, Soil physical properties, Unsaturated flow, Soil water movement, Sorption, Numerical analysis, Soil water, Diffusivity.

A new method was proposed for determining the dependence of soil water diffusivity and conductivity on water content or pressure head in the tensiometer range. A weighted mean diffusivity is used to linearize the one-dimensional absorption problem. The resulting cumulative absorption is equated to that of the exact nonlinear solution to obtain an expression for the diffusivity in terms of sorptivity. To use this result, sorptivities must be measured for a series of step-function increases in the water content (pressure head) at the absorption interface. Such sorptivity measurements are quickly and easily made in situ. The method was tested on a numerical example with nearly perfect results. Also, sorptivity measurements were made on laboratory soil columns and the derived hydraulic conductivities compared well with those measured directly under steady state conditions.

75:020-017
INFLUENCE OF SOIL MICROSTRUCTURE ON WATER CHARACTERISTICS OF SELECTED HAWAIIAN SOILS
Tsuji, G.Y., Watanabe, R.T., and Sakai, W.S.
Hawaii Agricultural Experiment Station, Honolulu.
Soil Science Society of America Proceedings, Vol. 39, No. 1, p 28-33, January-February 1975. 7 fig, 3 tab, 13 ref.

Descriptors: *Soil structure, *Soil physical properties, *Soil water, *Electronic equipment, Temperature, Retention, Soil texture, *Hawaii, Bulk density, Anisotropy, Montmorillonite, Kaolinite.

The higher water-holding capacity of Oxisols and Ultisols compared to that of the Vertisols and Inceptisols at 15 bars of suction was attributed to the presence of intraaggregate void spaces. Existence of such voids was verified with the aid of a scanning electron microscope. These voids were obvious in soils with kaolinitic and oxidic mineralogy but were not evident in soils of montmorillonitic or amorphous oxide composition.

75:02G-018
EFFECT OF STONES ON THE HYDRAULIC CONDUCTIVITY OF RELATIVELY DRY DESERT SOILS,
Mehuys, G.R., Stolzy, L.H., and Weeks, L.V.
California University, Riverside. Department of Soil Science and Agricultural Engineering.
Soil Science Society of America Proceedings, Vol. 39, No. 1, p 37-42, January-February 1975. 8 fig, 4 tab, 13 ref.

Descriptors: *Soil water, *Soil water movement, *Bulk density, *Hydraulic conductivity, Laboratory tests, Tensiometers, Volumetric analysis, Gravimetric analysis, Deserts, Soils.

The objective was to determine whether moisture transmission properties of stony soils could be evaluated using samples of the same soil in which the stony fraction (greater than 2 mm) had been excluded. Experiments were conducted in the laboratory on soil columns with and without stones. Unsaturated hydraulic conductivity was measured with a transient outflow method over the matric potential range of -0.05 to -50 bars by using tensiometers and soil psychrometers. On a weight basis, the soils studied contained up to 40% stones greater than 2 mm in diameter. If expressed as a function of matric potential, hydraulic conductivity values were similar, with or without stones. Soil water potential as measured by tensiometers or by thermocouple psychrometers was not affected by stones because these instruments respond to moisture changes in the soil portion only. When unsaturated hydraulic conductivity was expressed as a function of volumetric water content, the apparent conductivities were higher for a given water content when stones were present. A simple correction of water contents of stone-free samples, based on the stone volume of each soil, adequately accounted for differences observed when water contents were computed on a total volume basis.

75:02G-019
LANDFORM-SOIL-VEGETATION-WATER CHEMISTRY RELATIONSHIPS, WRIGLEY AREA, N.W.T.:
II. CHEMICAL, PHYSICAL, AND MINERALOGICAL DETERMINATIONS AND RELATIONSHIPS,
Walmsley, M.E. and Lavkulich, L.M.
British Columbia University, Vancouver. Department of Soil Science.
Soil Science Society of America Proceedings, Vol. 39, No. 1, p 89-93, January-February 1975. 3 tab, 18 ref.

Descriptors: *Soil-water-plant relationships, *Water chemistry, *Mineralogy, *Permafrost, *Canada, Geomorphology, Alpine, Grasslands, Colluvium, Bogs, Lakes, Streams, Soil formation, Clay minerals, Ice, Physical properties.

The relationship among five landforms in terms of chemical, physical, mineralogical, and water chemistry of lakes and the through flowing streams was presented. The landforms occur as a catenary sequence (toposequence) in the intermittent permafrost region of the Mackenzie Valley, Northwest Territories, Canada. The five landforms were identified as an alpine meadow, an area of stone stripe and stone ring formation, a colluvial slope, an area of coalescing fans, and an area of polygonal bog formation. Information collected on the chemical quality of a stream flowing through the area included pH, O2, Ca, Mg, Na, K, Cl, P and NO3. Chemical, physical, and mineralogical analyses of the soils occurring on these landforms illustrated the effect of climate on soil genesis. Cryoturbic action is the dominant process occurring in the stone stripe area while ice segregation is predominant in the area of polygonal bog formation. The limited decomposition of the soil organic matter is related to the harsh climate.

Subdued pedogenic development of soils in the coalescing fan area is evident by their youthful profile differentiation. Water chemistry demonstrated the functional and integrated effect between dissolved load in the water and the landform through which the stream has flown.

75:02G-020
A NEW CERAMIC CUP SOIL-WATER SAMPLER,
Harris, A.R., and Hansen, E.A.
Forest Service (USDA), La Crosse, Wisconsin, Watershed Lab.
Soil Science Society of America Proceedings, Vol. 39, No. 1, p 157-158, January-February 1975. 1 fig, 5 ref.

Descriptors: *Soil water, *Water sampling, *Instrumentation, Sampling, Water pollution.

A newly designed soil-water sampler utilizing a miniature porous ceramic cup was suitable for either collecting large samples or for microtechniques. It eliminated sample transfer in the field and contamination from water channeling along sampler, and can be enclosed to discourage vandalism. It also permitted immediate preservation of the collected sample.

75:02G-021
FIELD DETERMINATION OF HYSTERESIS IN SOIL-WATER CHARACTERISTICS,
Royer, J.M., and Vachaud, G.
Universite Scientifique et Medicale de Grenoble (France). Institut de Mecanique.
Soil Science Society of America Proceedings, Vol. 39, No. 2, p 221-223, March-April 1975. 3 fig, 12 ref.

Descriptors: *Soil water, *Hysteresis, On-site investigations, *Soil moisture, *Soil physical properties, Soils, Soil tests, Soil investigations, Moisture, Moisture content, Moisture availability, Soil moisture meters, Instrumentation, Soil density, Water pressure.

It is still a common practice to infer field values of soil water content (or of soil water suction) from the measurement of the soil water suction (or the soil water content) and the use of 'representative' soil water characteristics. A series of independent measurements of changes in water content and in soil suction were conducted on two watersheds during one year. It was shown on both sites that hysteresis is too important to be neglected, and that considerable errors will result from the determination of both water content and soil suction with the use of a single sensor.

75:02G-022
FINITE ELEMENT ANALYSIS OF TWO-DIMENSIONAL FLOW IN SOILS CONSIDERING WATER UPTAKE BY ROOTS: I. THEORY,
Neuman, S.P., Feddes, R.A., and Bresler, E.
Agricultural Research Organization, Bet-Dagan (Israel). Inst. of Soils and Water.
Soil Science Society of American Proceedings, Vol. 39, No. 2, p 224-230, March-April 1975. 3 fig, 1 tab, 8 ref, 1 append.

Descriptors: *Finite element analysis, *Soil water movement, *Unsaturated flow, *Soil-water-plant relationships, *Root systems, Absorption, Numerical analysis, Mathematical models, Soil moisture, Porous media, Hydraulic conductivity, Flow, Air-earth interfaces, Boundaries(Surfaces), Seepage, Infiltration, Anisotropy, Equations, Evaporation.

The problem of two-dimensional nonsteady flow of water in unsaturated and partly saturated porous media was solved by a Galerkin-type finite element approach. Particular emphasis was placed on the simulation of atmospheric boundaries and on water uptake by plant roots. The finite element method was shown to have several advantages over conventional finite difference techniques. It can easily handle nonuniform flow regions having irregular boundaries and arbitrary degrees of local anisotropy. Nonlinear atmospheric boundary conditions along evaporation or infiltration surfaces and along seepage faces were handled by a unique procedure. This iterative procedure relies on the ease with which flux normal to any boundary of the flow region is assigned in the finite element approach. Experience with this method indicates that rapid rates of convergence can be achieved in many cases.

75:020-023
FINITE ELEMENT ANALYSIS OF TWO-DIMENSIONAL FLOW IN SOILS CONSIDERING WATER UPTAKE BY ROOTS: II. FIELD APPLICATIONS,
Feddes, R.A., Neuman, S.P., and Bresler, E.
Institute for Land and Water Management Research, Wageningen (Netherlands).
Soil Science Society of America Proceedings, Vol. 39, No. 2, p 231-237, March-April 1975. 12 fig, 6 ref.

Descriptors: *On-site tests, *Field crops, *Mathematical models, *Finite element analysis, *Soil water movement, Unsaturated flow, Soil-water-plant relationships, Root systems, Anisotropy, Absorption, Numerical analysis, Soil moisture, Hydraulic conductivity, Evapotranspiration, Ditches, Water table, Soil properties, Hydraulic gradient, Infiltration, Simulation analysis.

Part I described a Galerkin-type finite element approach to the simulation of two-dimensional transient flow in saturated-unsaturated soils considering evaporation and water uptake by roots. The purpose of Part II was to verify the numerical model against field measurements, to compare the results with those obtained by a finite difference technique, and to show how the finite element method can be applied to complex but realistic two-dimensional flow situations. Two examples were given. The first concerns one-dimensional flow and it compares numerical results with those obtained experimentally in the field from water balance studies on red cabbage (Brassica oleracea L. 'Rode Herfst') grown on a clay soil in the presence of a water table. The second example describes two-dimensional flow in a complex field situation in The Netherlands where flow takes place under cropped field conditions through five anisotropic layers. Water is supplied to the system by infiltration from two unlined ditches and is withdrawn from the system by evapotranspiration and by leakage to an underlying pumped aquifer.

75:020-024
EVALUATING SURFACE-SOIL WATER CONTENT BY MEASURING REFLECTANCE,
Skidmore, E.L., Dickerson, J.D., and Schimmelpfennig, H.
Agricultural Research Service, Manhattan, Kansas.
Soil Science Society of American Proceedings, Vol 39, No. 2, p 238-242, March-April 1975. 7 fig, 1 tab, 24 ref.

Descriptors: *Soil moisture meters, *Soil moisture, *Instrumentation, Soil water, Soil surfaces, Reflectance, Soil erosion, Infrared radiation, Soils, Soil properties.

Water's property to absorb certain wavelengths in the near infrared was the basis for developing a reflectometer to measure reflectance of near-in-frared radiation from a soil surface. The reflectometer's essential elements include: source of infrared radiation, optical system, integrating sphere, detector, light chopper, amplifier, and meter system. The radiation from an incandescent lamp was filtered with a narrow-band pass filter, chopped, and allowed to strike the test surface where it was either absorbed or reflected onto the surface of the integrating sphere. The intensity of the reflected radiation was measured with a lead sulfide detector and appropriate amplifer and meter. The reflectance as a function of water content was measured for filter paper and several soils at 1.30, 1.45, 1.65, and 1.95 micrometers. Although at low water contents soil properties (other than water content) strongly influenced soil reflectance, at 1.95-micrometer wavelength--the most prominent absorption band of liquid water--the reflectance-content relationship tended to be log-linear.

75:02G-025
SOIL WATER HYSTERESIS IN A FIELD SOIL,
Watson, K.K., Reginato, R.J., and Jackson, R.D.
Agricultural Research Service, Phoenix, Arizona, Water Conservation Lab.
Soil Science Society of America Proceedings, Vol. 39, No. 2, p 242-246, March-April 1975. 5 Fig, 11 ref.

Descriptors: *Soil water, *Hysteresis, On-site investigation, *Soil moisture, *Soil physical properties, Soil, Soil tests, Soil investigations, Moisture, Moisture content, Moisture availability, Soil moisture meters, Instrumentation, Soil density, Water pressure, Tensiometers, Bulk density.

The requirements for the measurement in the field of the hysteresis characteristics of the soil water pressure (h)-water content (theta) relationship were discussed and details given of the method whereby an undisturbed hexagonal monolith of soil was isolated from the surrounding soil. The instrumentation used in measuring the soil water movement in this monolith, with particular reference to h and theta measurements at points in the soil profile, was described. The shapes of typical theta-time and h-time curves were discussed in relation to possible hysteresis, and the actual h(theta) relationship for soil at the 8-to 9-cm depth was determined.

75:02G-026
DRAINAGE CHARACTERISTICS OF SOILS,
Corey, A.T., and Brooks, R.H.
Colorado State University, Fort Collins. Department of Agricultural Engineering.
Soil Science Society of America Proceedings, Vol. 39, No. 2, p 251-255, March-April 1975. [illegible] Fig, 12 ref.

Descriptors: *Soil moisture, *Soil water movement, *Conductivity, *Pore pressure, Drainage effects, Percolation, Moisture tension, Moisture content, Negative pore pressure, *Drainage.

Evidence was obtained indicating that neither water conductivity nor water content are single-valued functions of soil water suction during a period in which soil is draining continuously. Functional relationships between water conductivity and soil water suction measured during continuous drainage were found to be different from those frequently observed during steady-state experiments. During drainage, a finite suction is recorded before a soil begins to desaturate and this suction is often larger than the suction existing immediately after drainage starts. It was postulated that the reduction in suction is a result of air reaching larger (previously isolated) pores.

75:02G-027
PREDICTION OF INFILTRATION OF WATER INTO AGGREGATED CLAY SOIL SAMPLES,
Gumbs, F.A., and Warkentin, B.P.
Macdonald Coll., Ste. Anne de Bellevue (Quebec). Department of Soil Science.
Soil Science Society of America Proceedings, Vol. 39, No. 2, p 255-263, March-April 1975. 12 Fig, 4 tab, 20 ref.

Descriptors: *Soil properties, *Infiltration, *Aggregates, Model studies, Laboratory tests, Hysteresis, Conductivity, Diffusivity, Soil pressure, Retention, Wetting, Drying, Moisture content, Percolation, Gravity, Tensiometers, Bulk density, Stability, Sampling.

Physical properties--stability, water retention, diffusivity, and conductivity--relevant to the study of infiltration into aggregated media were measured for four aggregate sizes. These media were considered stable to infiltration. The hysteresis in moisture retention, equilibrium moisture retention curves, and the changes in moisture retention with time were measured for confined and unconfined samples of the aggregates. Wetting and drying diffusivities and conductivities were also measured and used in the prediction of horizontal and vertical infiltration under zero and small negative pressures into columns of each aggregate sion by using the diffusion equation. Diffusivities and conductivities were larger on wetting than on drying and generally larger in unconfined than in confined samples. Horizontal and vertical infiltration were reasonably well predicted when water infiltrated under negative pressure and the diffusivities and conductivities used were calculated from infiltration profiles developed under the same water tension. For these media, the values of water tension, diffusivity, and conductivity at any water content depend on the rate of wetting. The values to be used in the prediction of infiltration must therefore be measured for times of wetting which correspond to the duration of infiltration. The classical diffusion equation can be used to predict infiltration into aggregated clay soils if the correct diffusivities and conductivities are used.

75:02G-028
TWO-DIMENSIONAL SIMILARITY SOLUTION: THEORY AND APPLICATION TO THE DETERMINATION OF SOIL-WATER DIFFUSIVITY,
Turner, N.C., and Parlange, J-Y
Connecticut Agricultural Experimental Station, New Haven. Department of Ecology and Climatology.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 387-390, May-June 1975. 3 fig, 1 tab, 5 ref.

Descriptors: *Soil water, *Infiltration, *Infiltration rates, Diffusion, Moisture content, Sands.

A similarity solution exists in two-dimension when a constant flux is imposed along a line source. Following the Bruce and Klute method in one-dimension, this similarity solution can be used to determine the soil water diffusivity. The application of the method was illustrated for a sandy loam. The advantage of the method is that the slope of the moisture profile is finite and easily measured, even close to the source.

75:02G-029
SOIL WATER MEASUREMENT WITH AN INEXPENSIVE SPECTROPHOTOMETER,
Bowers, S.A., Smith, S.J., Fisher, H.D., and Miller, G.E.
Agricultural Research Service, Durant, Oklahoma. Water Quality Management.
Soil Science Society of America Proceeding, Vol. 39, No. 3, p 391-393, May-June 1975. 4 fig, 1 tab, 3 ref.

Descriptors: *Soil water, *Water measurement, *Instrumentation, *Soil moisture meters, *Spectrometers, On-site tests, Analytical techniques, Electronic equipment, Moisture, Moisture content, Evaluation, Available water, Soil moisture, Soil properties, Moisture availability, Spectrophotometry, Clay loam, Silts, Clays, Sands, Absorption.

A small, portable, battery-powered, spectrophotometer was developed to measure soil water content rapidly. Soil water contents of 16 soils were related to the absorbance at 1.94 micrometers by a soil-methanol extract by the curvilinear equation: Absorbance = A(% soil water/100 + 1.025(% soil water)) + a. With the exception of Houston Black Clay, one equation could be used for all soils. Determination time for individual samples was approximately 15 min.

75:02G-030
ON SOLVING THE FLOW EQUATION IN UNSATURATED SOILS BY OPTIMISATION: HORIZONTAL INFILTRATION,
Parlange, J-Y
Connecticut Agricultural Experiment Station, New Haven. Department of Ecology and Climatology.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 415-418, May-June 1975. 1 tab, 11 ref. 1 append.

Descriptors: *Unsaturated flow, *Absorption, *Diffusivity, Soils, Soil water, Soil physics, Soil mechanics, Infiltration, Mathematics, Mathematical studies, Optimization, Subsurface waters, Soil moisture, Flow, Diffusion, Soil water movement, Agriculture, Agronomy, Clays, Labor.

Recently, integral methods have been developed that provide accurate approximations to the diffusion equation with rapidly varying diffusivity, but require in general some numerical iteration. A new analytical approach was developed which yields optimal approximation without any numerical iteration. The method was applied to the problem of one-dimensional horizontal infiltration of water in soils. It was shown that the sorptivity is an invariant, which can be expressed in terms of the sum of two integrals involving the diffusivity. The analytical results were in excellent agreement with numerical calculations for Yolo light clay. Since diffusivity for most soils varies even more rapidly than for Yolo light clay, the approach should prove even more accurate for most soils. The technique is quite general and can be adapted to solve other problems of water movement in unsaturated soils.

75:020-011
A ONE-STEP WETTING PROCEDURE FOR DETERMINING BOTH WATER CHARACTERISTIC AND HYDRAULIC CONDUCTIVITY OF A SOIL CORE,
Ahuja, L.R.
Hawaii University, Honolulu. Department of Agronomy and Soil Science.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 418-423, May-June 1975. 9 Fig, 8 ref.

Descriptors: *Hydraulic conductivity, *Soil water movement, *Unsaturated flow, Soil mechanics, Soil physics, Soil physical properties, Numerical analysis, Laboratory tests, Diffusivity, Soils, Soil water, Soil properties, Soil moisture, Agriculture, Agronomy, Wetting.

Reasonable simplifications were used to obtain both the suction-water content and unsaturated hydraulic conductivity relationships from data measured during wetting of a relatively dry soil core through a high-hydraulic-resistance porous plate. For soil-water contents below the bubbling-pressure value, the two functions were assumed to be of previously known power forms. The resulting similarity was then utilized to obtain these functions from cumulative inflow and wetting-front position data, using an iterative numerical solution of the ordinary differential equations. Accuracy of the solution was tested on a set of generated data. Tests of the technique as a whole on generated data for one soil and experimental data for another showed it to be promising. For water contents above the bubbling-pressure value, a method was suggested to obtain the two hydraulic properties from cumulative inflow and soil-water suction at the other end of the core.

75:020-012
MATHEMATICAL ANALYSIS OF STEADY SATURATED FLOW THROUGH A MULTILAYERED SOIL WITH A SLOPING SURFACE,
Selim, H.M., Selim, M.S., and Kirkham, D.
Florida University, Gainesville. Department of Soil Science.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 445-453, May-June 1975. 12 Fig, 3 tab, 16 ref.

Descriptors: *Saturated flow, *Seepage, *Slopes, *Infiltration, Potential flow, Saturated soils, Soil water movement, Mathematical studies, Mathematical models, Model studies, Hydraulic conductivity, Permeability, Soil water, Groundwater movement,Groundwater potential, Flow, Soils.

An analytical solution was presented for a two-dimensional multilayered hillside seepage problem. The soil was horizontally stratified with each layer having a different permeability. The flow medium was assumed to be water-saturated to the soil surface, bounded below by an impermeable barrier at a finite depth, and bounded laterally by vertical streamlines. Seepage occurred into the flow medium along the upper part and out along the lower part of the sloping soil surface. Two situations were analyzed, one with a constant slope soil surface and another with an arbitrarily shaped soil surface. The potential and stream functions for the problem were developed by starting with a general series solution to Laplace's equation and using a modified Gram-Schmidt method to determine the series coefficients. Solutions were derived for two-layered and three-layered soils. From these derivations, solutions for soils with more than three layers could be readily deduced. The results presented include flow nets, seepage velocities, and infiltration rates for two-layered and three-layered soils.

75:02G-033
A COMPARISON OF THE GREEN - AMPT AND PHILIP TWO-TERM INFILTRATION,
Fok, Y-S.
Hawaii University, Honolulu, Civil Engineering Department.
Transactions of the American Society of Agricultural Engineers, Vol. 18 No. 6, p 1073-1075, November-December 1975. 1 tab 13 ref.

Descriptors: *Infiltration, *Mathematical studies, Equations, Soil water movement.

For the benefit of the users of both the Green - AMPT and Philip two-term equations, it is shown in this paper that the Philip two-term equation can be derived from the Green - AMPT equation and differences between these two equations are evaluated.

75:02G-034
TOTAL NITROGEN USING A SODIUM HYDROXIDE INDEX AND DOUBLE SAMPLING THEORY,
Geist, J.M., Hazard, J.W.
Pacific Northwest Forest and Range Experiment Station, La Grande, Oregon 97850.
Soil Science Society of America Proceedings, Vol. 39, No. 2, p 340-343, March-April 1975. 1 fig, 1 tab, 8 equ, 9 ref.

Descriptors: *Nitrogen, *Regression analysis, Soil chemistry, Soil properties, Soil investigations, Soil tests.

A regression relationship was investigated between total Kjeldahl soil N and an NaOH distillable fraction of soil N. The correlation coefficient r was 0.989 for 45 soil samples. A double sampling approach using both analyses to estimate total N was more efficient than Kjeldahl analyses only. Example applications are presented under cost and precision limitations. The regression can also be used to obtain point values of total N for mapping or other nonstatistical purposes.

75:02G-035
SODIUM AVAILABILITY IN NONALKALI SOILS,
Suarez-Hernandez, A., Hanway, J.J.
Soil Science Society of America Proceedings, Vol. 39, No. 2, p 308-311, March-April 1975. 3 fig, 2 tab, 17 ref.

Descriptors: *Sodium, *Soil investigations, *Soil chemistry, *Soil chemical properties, Soil management, Iowa.

Ryegrass was grown in the greenhouse on undried soil samples from the 0 to 15 and 30 to 45 cm depths of 15 Iowa soils. The NH4OAc exchangeable Na was 21 ppm or less in all soil samples except those from the 30 to 45 [illegible]pth in southern Iowa soils, which contained 38 to 115 ppm exchangeable Na. The [illegible] of these southern Iowa subsurface samples varied from 5.1 to 6.0. Percentages of Na in the first harvest of ryegrass were directly related to the exchangeable Na contents of the soils and inversely related to exchangeable soil K and K content of the plants.

75:02G-036
SPATIAL VARIABILITY IN SOILS BELOW DEPTH OF TILLAGE: BULK DENSITY AND FIFTEEN ATMOSPHERE PERCENTAGE,
Cassel, D.K., Bauer, A.
North Carolina State University, Raleigh 27607.
Soil Science Society of America, Vol. 39, No. 2, p 247-250, March-April, 1975. 5 fig, 3 tab, 5 ref.

Descriptors: *Spatial distribution, *Soil investigations, Soil properties, Soil texture, Bulk density, Soil water, Soil pressure.

Soil bulk density (D) and 15-atm percentage (FAP) were measured for three soils--Maddock sandy loam, Rearden silty clay, both of glacio-lacustrine origin. D and FAP were measured in approximately 10-cm increments from a depth of 30 to 152 cm.

75:02D-037
REDUCTION OF NITRATE IN A SOIL COLUMN DURING CONTINUOUS FLOW,
Ardakani, M.S., Belser, L.W., McLaren, A.D.
California University, Berkeley.
Soil Science Society of America Proceedings, Vol. 39, No. 2, p 290-294, March-April 1975. 5 fig, 2 equ, 31 ref.

A column packed with a homogenous Hanford sandy loam soil was perfused continuously with a solution containing 200 ppm NO3(-)-N and 2400 ppm glucose-C. Weekly estimates of denitrifiers showed that populations increased from 10(2) to > 10(8)/g of soil. Denitrifiers were most abundant near the surface where NO3(-)-N almost totally disappeared from the soil solution. An organic matter profile characterized by a surface layer developed within 3 weeks. Accumulated organic N accounted for about 4% of the total applied NO3(-)-N while the remaining 96% disappeared, presumably by dissimilation, within the top 0.5 cm of the surface layer. Normalized rate constants from 1.3 times 10(-5) ppm/hour(.)cm) per organism were estimated for dissimilation of NO3(-)-N from its profiles. In a similar experiment, but without added glucose, less of the NO3(-)-N disappeared from solution; the percentage decreased from 40 to 15% with time.

75:02D-038
DENITRIFICATION RATES IN RELATION TO TOTAL AND EXTRACTABLE SOIL CARBON,
Stanford, G., Vander Pol, R.A., Dzienia, S.
Agricultural Research Service, U.S. Department of Agriculture, Beltsville, MD.
Soil Science Society of America Proceedings, Vol. 39, No. 2, p 284-289, March-April 1975. 3 fig, 5 tab, 18 ref.

Descriptors: *Denitrification, *Soil investigations, *Soil chemistry, *Soil chemical properties, Carbon.

Denitrification rates were studied under near-anaerobic conditions in 30 soils of diverse origin that differed widely in pH, organic C contents, and other characteristics. Soils with added NO3-N were submerged in water and containers were sealed to prevent further oxygen intake during incubation. Disappearance of NO3-N and production of NH4-N were determined at 1-day intervals or longer over a 10-day period. Since soils were not shaken during incubation, denitrification rates were influenced by diffusion of nitrate from the liquid to the soil layer. In most soils, amounts of NO3-N declined exponentially with time of incubation. Thus, under the experimental conditions, the loss of nitrate was depicted better by log NO3-N vs. time (t, hours) than ppm NO3-N vs. t.

75:02D-039
RETENTION OF ARSENIC BY HYDROXY-ALUMINUM ON SURFACES OF MICACEOUS MINERAL COLLOIDS,
Huang, P.M.
Soil Science Society of America Proceedings, Vol. 39, No. 2, p 271-274, March-April 1975. 3 fig, 7 tab, 19 ref.

Descriptors: *Soil chemistry, *Arsenic compounds, Soil properties, Soil investigations, Soil chemical properties.

This study was carried out to examine the relative significance of As retention by hydroxy-Al on external and interlamellar surfaces of micaceous mineral colloids. Depletion of K from muscovite and biotite decreased As retention. This effect was attributed to the exclusion of arsenate ions by the K-depleted layers. Hydroxy-Al in the interlamellar spaces of vermiculite and K-depleted micas was not found to contribute significantly to As retention in the solution concentration range of 2 to 10 ppm As.

75:020-040
A FIELD STUDY OF SOIL WATER DEPLETION PATTERNS IN PRESENCE OF GROWING SOYBEAN ROOTS: III, ROOTING CHARACTERISTICS AND ROOT EXTRACTION OF SOIL WATER,
Arya, L.M., Blake, G.R., Farrell, D.A.
Minnesota University, St. Paul, Minnesota.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 437-444, May-June 1975. 8 Fig, 3 tab, 7 equ, 10 ref.

Descriptors: *Soybeans, *Soil water, *Soil water movement, Soil properties, Soil-water-plant relationships, Root systems, Root development, Root distribution, Root zone.

Rooting characteristics and water extraction patterns in the root zone of a mature soybean crop were determined in the field. Rates of water extraction by the roots in the various 10-cm intervals were computed over an irrigation-drying cycle, 81 to 91 days after planting. In the 10- to 30- and 60- to 70-cm layers the extraction rate decreased with time. In the 30- to 60-cm layer an initial decrease was followed by a substantial increase later in the cycle. Total extraction between 49 and 210 hours after irrigation decreased with depth--1.12 cm in the 10- to 20-cm layers and 0.25 cm in the 60- to 70-cm layers. Extraction rate for the 10- to 70-cm soil during the 47- to 56- and 81- to 91-days growth periods showed an initially rapid decrease following irrigation but reached constant levels of 0.48 and 0.39 cm/day, respectively.

75:020-041
A FIELD STUDY OF SOIL WATER DEPLETION PATTERNS IN PRESENCE OF GROWING SOYBEAN ROOTS: II. EFFECT OF PLANT GROWTH ON SOIL WATER PRESSURE AND WATER LOSS PATTERNS,
Arya, L.M., Blake, G.R., Farrell, D.A.
Minnesota University, St. Paul, Minnesota.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 430-436, May-June 1975. 9 Fig, 1 tab, 15 ref.

Descriptors: *Soybeans, *Soil water, *Soil water movement, Soil properties, Soil-water-plant relationships, Root systems, Plant growth, Root zone.

Soil-water pressure and water-loss patterns in the root zone of soybean were determined from daily observations during irrigation-drying cycles for four growth periods after planting. Tensiometric measurements of soil water pressure were made on a 10-cm square grid from one plant row to an adjacent one spaced 80 cm apart, and between 10- and 70-cm depths. Water contents were inferred from pressure-water content relationships.

75:020-042
A FIELD STUDY OF SOIL WATER DEPLETION PATTERNS IN PRESENCE OF GROWING SOYBEAN ROOTS: I. DETERMINATION OF HYDRAULIC PROPERTIES OF THE SOIL,
Arya, L.M., Farrell, D.A., Blake, G.R.
Minnesota University, St. Paul, Minnesota.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 424-429, May-June 1975. 6 Fig, 3 tab, 8 ref.

Descriptors: *Soybeans, *Soil water, *Soil physical properties, Soil properties, Soil water movement, Soil-water-plant relationships, Root systems, Hydraulic conductivity, Root zone.

The hydraulic properties of a Waukegan loam profile were determined by field and laboratory procedures. Pressure-water content relationships obtained in the laboratory were found to be variable at pressures above -100 cm of water. In this range field data were considered more reliable. Hydraulic conductivity in the field was determined from flux and hydraulic-head gradient data. Hydraulic-head gradients were obtained from tensiometric measurements of pressure at various depths. In the soil profile that was subject to both evaporation and drainage, the position of a downward moving "zero flux" boundary was determined. Flux across any depth was obtained by integrating the rate of change of water content with time between the "zero flux" boundary and the depth in question.

75:02G-043
A NEW TECHNIQUE FOR RAPID AND CONTINUOUS MEASUREMENT OF REDOX POTENTIALS,
Lineberger, R.D., Whisler, F.D., Lance, J.C.
Lockheed, Missiles and Space Co., Sunnyvale, CA
Soil Science Society of America Proceedings, Vol. 39, No. 2, p 375-377, March-April, 1975. 2 fig, 2 ref.

Descriptors: *Laboratory tests, *Electrodes, Soil tests, Sewage, Sewage disposal.

A new "salt bridge" technique for the rapid and continuous measurement of redox potentials at various depths in multiple soil columns, utilizing only one calomel electrode, is described. The method was compared with a previous technique where a reference electrode was placed in each of 8 soil columns, containing a total of 42 platinum redox probes. A least-squares best fit statistical analysis indicated that the new technique yields redox potential measurements as accurate as those of the previous method. Several other features of the salt bridge technique make it advantageous for use both in the laboratory and in the field.

75:02G-044
USE OF AMMONIA ELECTRODE FOR DETERMINATION OF CATION EXCHANGE CAPACITY IN SOIL STUDIES,
Miller, G.A., Riecken, F.F., Walter, N.F.
Iowa State University, Ames, Iowa.
Soil Science Society of America Proceedings, Vol. 39, No. 2, p 372-373, March-April 1975. 1 fig, 7 ref.

Descriptors: *Cation exchange, Soil tests, Soil properties, Soil investigations, Laboratory tests, Electrodes.

Cation exchange capacity (CEC) was determined with an ammonia electrode on 17 horizon samples from four soil profiles. The profiles selected to test this procedure had a wide range of physical and chemical properties. The procedure was a modification of other techniques. Centrifugation was employed for removal of exchangeable cations and ammonium salts. The CEC values obtained with the ammonia electrode agreed closely with values obtained by direct distillation for adsorbed ammonia. The method was simple and rapid and suitable for soil studies. Using the proposed method a single operator could carry out the analysis of 16 or more samples in a normal working day.

75:02G-045
THE USE OF A DEPENDENT DOMAIN MODEL OF HYSTERESIS IN NUMERICAL SOIL WATER STUDIES,
Lees, S.J., Watson, K.K.
New South Wales University, Kensington (Australia). School of Engineering.
Water Resources Research, Vol. 11, No. 6, p 943-948. December 1975. 4 fig, 19 ref.

Descriptors: *Soil water movement, *Hysteresis, *Unsaturated flow, *Model studies, Numerical analysis, Soil water, Soil pressure, Soil moisture, Moisture content, Infiltration, Moisture tension, Subsurface waters, Recharge, Drainage effects, Mathematical models, Gravitational water.

The analysis of intermittent soil water systems requires the inclusion of a capillary hysteresis model in the space-time simulation of the flow process. Domain models of hysteresis were reviewed, and the approach of Poulovassilis and Childs

(1971) was selected as the basis for a numerical hysteresis program which enabled the generation of primary, secondary, and higher order scanning curves. The dependence of the pore draining pressure on the pressure at the previous reversal was restricted to reversals from the boundary curves. This enabled the distribution function to be approximated by a series of regularly spaced, independent domain-type distribution diagrams, each being derived from an experimental primary curve and a set of estimated secondary scanning curves. The effectiveness of the approach was demonstrated by simulating the movement of water in a profile of experimental sand subject to intermittent infiltration-redistribution sequences. In particular, the hysteretic path followed by the surface node was used to illustrate the generation of the necessary higher order scanning curves.

75:02G-046
PREDICTING ANION MOVEMENT IN DISTURBED AND UNDISTURBED SOILS,
Cassel, D.K.; Van Genuchten, M.T.; Wierenga, P.J.
North Carolina State University, Raleigh. Department of Soil Science.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1015-1019, November-December 1975. 6 fig, 22 ref.

Descriptors: *Anions, *Ion transport, *Soils, Cores, Laboratory tests, Tracers, Chlorine radioisotopes, Nitrates, Numerical analysis, Mathematical models, Equations, Convection, Diffusion, Nitrification, Soil water, Pore water, Velocity, Depth, Soil texture, Bulk density, Solutes, Loam, *Forecasting.

Prediction of anion displacement in soils has proven difficult owing to anion exclusion and the occurrence of anion sources or sinks within the soil system. In addition, variations in bulk density and texture with depth cause mean pore water velocity and soil water content to be functions of depth. A numerical solution of a modified convective diffusion equation, which accounts for apparent anion exclusion and variations in soil water content and mean pore water velocity as functions of depth, was discussed. Moreover, a zero-order rate term was incorporated to account for nitrification occurring in the upper portion of the soil profile. The model was tested using previously published NO3 and Cl36 displacement data for disturbed and undisturbed cores of Aberdeen loam. The model predicted Cl36 displacement well. Incorporation of the source term improved prediction of the nitrate breakthrough curve, but agreement of the predicted curve with observed data was only fair. When average values for water content and bulk density were used throughout the entire column, instead of depth dependent values, the description of anion displacement may be less than the variation in solute movement observed among replicate soil cores.

75:02G-047
WATER FLUX AND ELECTRICAL POTENTIALS IN WATER-SATURATED BENTONITE,
Gairon, S.; Swartzendruber, D.
Purdue University, Lafayette, Indiana. Agricultural Experiment Station.
Soil Science Society of America Proceedings, Vol. 39, No. 5, p 811-817, September-October 1975. 6 fig, 1 tab, 8 ref.

Descriptors: *Zeta potential, Flow, *Hydraulic gradient, *Bentonite, Saturated flow, Clays, Seepage, Permeameters, Hydraulic properties, Hydraulic conductivity, Equipment, Laboratory tests, Hysteresis, Expansive clays.

Electrical potential, water flux, and hydraulic gradient were studied for saturated water flow through plugs of sodium bentonite at concentrations ranging from 11.5 to 35.1% clay. A special permeameter with an adjustable piston allowed measurements to be taken with a given mass of clay, but with successively lower clay concentrations. At the lowest clay content, both electrical potential and water flux increased less than proportionally with increasing hydraulic gradient. This less-than-proportional behavior decreased as clay concentration increased, and, at 35.1% clay, proportional response to hydraulic gradient was obtained for both electrical potential and water flux. A less-than-proportional relationship between electrical potential and hydraulic gradient did not cause the water flux to increase more than proportionally with increasing hydraulic gradient, in contrast with what has been reported for nonswelling quartz powder and would be inferred from the classical double-layer theory of streaming potential and electroosmotic flow. The only indication of a more-than-proportional flux-gradient relationship was found for a 35.1% clay concentration, in the form of a linear relationship displaced to the right from the origin to yield a positive gradient intercept and a negative water flux at zero hydraulic gradient.

75:02G-048
A DEPENDENT DOMAIN MODEL OF CAPILLARY HYSTERESIS,
Mualem, Y., Dagan, G.
Technion-Israel Institute of Technology, Haifa. Faculty of Civil Engineering.
Water Resources Research, Vol. 11, No. 3, p 452-460, June 1975. 15 fig, 7 ref, 2 append.

Descriptors: *Hysteresis, *Capillary water, *Capillary fringe, *Mathematical models, Model studies, Wetting, Drying, Soil moisture, Soil water, Hygroscopic water, Pores.

A model of capillary hysteresis which takes into account the phenomenon of blockage against air (and water) entry was presented. The model was based on our previous (1974) model II, which predicts any hysteretic path with the aid of two functions, L(Psi). The model was generalized by adding a new function of pore blockage against air (and a function of pore blockage against water), as has been suggested by D. H. Everett (1967) and G.C. Topp (1971). It was found that the function of pore blockage against water is of a lesser significance and can be neglected in most cases. A technique of deriving L(Psi), U(Psi), and the function of pore blockage against water from the measured boundary loop and one primary drying scanning curve was presented. A simple method of predicting any hysteretic path was suggested. It was found that the generalized model leads to better results than the models based on independent domain theories for soils having a major portion of their hysteretic loop in the range of air entry value.

75:02G-049
FACTORS INFLUENCING INFILTRATION AND SEDIMENT PRODUCTION OF SEMIARID RANGELANDS IN NEVADA,
Blackburn, W.H.
Texas A and M University, College Station. Department of Range Science.
Water Resources Research, Vol. 11, No. 6, p 929-937, December 1975. 3 fig, 6 tab, 27 ref.

Descriptors: *Infiltration, *Erosion, *Sediment yield, *Watersheds(Basins), *Plant morphology, *Nevada, Soil structure, Antecedent moisture content, Simulated rainfall, Field capacity, Silts, Arid lands, Semiarid climates.

Simulated rainfall was used to study infiltration rates and sediment production of 28 plant communities and soils of five watershed areas in central and eastern Nevada. Two antecedent soil moisture conditions were used: soil initially air dry and initially at field capacity. Infiltration rates and sediment production of the various soils are largely controlled by extent and surface morphology of dune interspace soils. Pertinent factors are the depth of surface horizon, percent of carbon, pH, bulk density, and percent silt in the dunes. Vesicular horizons are unstable in dune interspace surface soils. These horizons seldom occur in coppice dunes or in well-aggregated dune interspace soils. Infiltration rate is negatively related, and sediment production positively related to the occurrence and morphology of vesicular horizons. More sediment is produced from soils with antecedent moisture initially at field capacity than from initially dry soil because of the instability of vesicular horizons when the soils were saturated.

75:02G-050
THE GROWTH OF DISTURBANCES IN UNSTABLE INFILTRATION FLOWS,

Philip, J.R.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia), Division of Environmental Mechanics.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1049-1053,
November-December 1975. 7 fig, 3 ref.

Descriptors: *Soil water movement, *Unsaturated flow, *Mathematical models, *Laboratory tests, *Infiltration, Hydrodynamics, Heterogeneity, Moisture content, Wetting, Depth, Pressure head, Atmospheric pressure, Velocity, Equations, Hydraulic conductivity.

The stability analysis of the delta-function model of infiltration yields a maximum wave-number for unstable disturbances, Mcrit, and a wave-number for maximum amplification, M*. The 'column effect,' i.e. the suppression of instability in laboratory columns, depends on Mcrit; and the dimensions of fingers in unstable flows can be expected to depend on M*. When instability is induced by a sudden jump of G, the water pressure gradient behind the wetting front, Mcrit and M* may be evaluated simply and directly. When, on the other hand, instability emerges during gradual increase of G, it is necessary to study the amplification of disturbances during the whole course of increase of G through positive values. Such a study was made for one example of instability induced by air compression and for one where it was induced by increase of conductivity with depth. Both exhibited qualitatively similar patterns of amplification: disturbances of small M (wave-number) begin to be amplified sooner, but ultimately overtaken by some disturbances of larger M starting later. Definite values of M* were found, and the results discussed with special reference to fingering and to the column effect.

75:020-051
WATER RETENTION BY CORE AND SIEVED SOIL SAMPLES,
Unger, P.W.
Agricultural Research Service, Bushland, Texas.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1197-1200,
November-December 1975. 2 fig, 2 tab, 13 ref.

Descriptors: *Soil water *Soil moisture, Moisture availability, Moisture content, Retention, Soil properties, Soil texture, Soil management, Water storage, Storage capacity, Cultivation, Sampling.

Mechanical analyses and water retention by core and sieved soil at -1/3 and -15 bar matric potentials were determined for samples from 26 sites ranging in texture from sand to clay. Objectives were to obtain a basis for identifying which soils may be influenced by deep tillage and profile modification with respect to water storage capacity and to determine the magnitude of errors possible when using sieved soils to establish field soil water contents. At -1/3 bar potential, cores retained more water than sieved soil when the water content was below 11%. The opposite occurred at higher water contents. At -15 bars potential, cores contained about 1 percentage point more water than sieved soils throughout the water content range encountered. These results showed that treatments which thoroughly disrupt the natural soil structure may decrease and increase the storage capacity of coarse- and fine-textured soils, respectively. When expressed as a percent of the core water content, differences between core and sieved soil contents at -1/3 bar potential ranged from -40 to +35% at 5 and 70% core water contents, respectively. At -15 bars potential, the range was from -52 to -4% at 5 and 25% core water contents, respectively. These differences indicate caution should be used when using sieved soils to infer water retention by field soils, regardless of texture.

75:021-052
IN SITU HYDRAULIC CONDUCTIVITY AT FOUR HILLSLOPE LOCATIONS IN A CLOSED DRAINAGE SYSTEM,
Matzdorf, K.D., Cassel, D.K., Worcester, B.K., Malo, D.D.
North Dakota State University, Fargo. Department of Soils.
Soil Science of America Proceedings, Vol. 39, No. 3, p 508-512, May-June 1975.
6 fig, 2 tab, 12 ref.

Descriptors: *Hydraulic conductivity, *Infiltration, *Glacial soils, *North Dakota, Till, Slopes, On-site investigations, Soil water movement, Soil water, Tensiometers, Soil physical properties, Irrigation, Groundwater movement, Unsaturated flow, Moisture content, Agronomy.

Virtually no information has been published concerning the hydraulic properties of large acreage of till plain soils associated with 'potholes' in northcentral United States and Canada. Objectives of research were to measure and compare in situ hydraulic conductivities and selected soil physical properties at several depths in four soil profiles on a till plain in southeastern North Dakota. Theoretical hydraulic conductivity values were calculated and compared with the in situ conductivities. Unsaturated soil hydraulic conductivity vs. depth was measured in situ at four sites on a toposequence developed from a glacial till. Water was allowed to infiltrate the soil at each site and the soil surface covered to prevent evaporation. During the ensuing drainage periods soil water pressure was monitored with triplicate tensionmeters at each of six depths. These depths were selected on the basis of soil morphology. Soil water characteristics, determined on triplicate 7.6- by 7.6-cm cores taken from the same depth as the tensiometers cups, were used in conjunction with soil water pressure data to compute hydraulic conductivities. Hydraulic conductivity generally increased with depth to about 90 cm. Below this depth, hydraulic conductivity tended to decrease. When the matching factor was selected from the midpoint of the measured hydraulic conductivity range, the conductivities computed by Green and Corey's method compared favorably with those measured in situ.

75:02G-053
IRRIGATION METHOD AS A DETERMINANT OF LARGE PORE PERSISTENCE AND CRUST STRENGTH OF CULTIVATED SOILS,
Kemper, W.D., Olsen, J.S., Hodgdon, A.
Colorado State University, Fort Collins. Department of Agricultural Engineering.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 519-523, May-June 1975. 6 fig, 1 tab, 6 ref.

Descriptors: *Wetting, *Air entrainment, *Irrigation systems, *Soil surfaces, *Soil physical properties, Hydraulic conductivity, Infiltration, Permeability, Interactions, Soil properties, Soil structure, Soil types, Wettability, Aeration, Saturated soils, Soil gases, Irrigation, Pores, Capillary conductivity, Pore pressure, Flooding, Soil aggregates, Saturation, Capillary action.

Air dried soils were wetted by flooding, immersion, slow immersion and capillary action resulting in successively slower rates of wetting. Slow capillrry wetting of a weekly structured soil allowed retention of more large size pore space than did rapid wetting of a well structured soil. Breaking strength of dried soils which had been wet by rapid immersion, capillary action, and capillary action followed by immersion, was much greater for soils wet by rapid immersion. Immersion following slow capillary wetting resulted in soils with intermediate breaking strengths. A study on corn (Zea mays L.) seedling emergence from a weakly structured soil showed less than 50% emergence for flooding and up to 100% for capillary wetting.

75:02G-054
EFFECT OF DAILY IRRIGATION ON WATER CONTENT AND SUCTION PROFILES IN SOILS OF THREE TEXTURES,
Miller, D.E.
Agricultural Research Service, Prosser, Washington. Western Region.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 512-515. May-June 1975, 5 fig, 5 ref.

Descriptors: *Irrigation effects, *Soil texture, *Soil water movement, *Soil types, *Moisture tension, Drainage effects, Evapotranspiration, Irrigation, Irrigation efficiency, Plant growth, Soil physical properties, Soil properties, Soil-water-plant relationships, Moisture content, Soil moisture, Soil profiles, Infiltration, Hydraulic conductivity.

Soil irrigated to replace just evapotranspiration losses produced profiles that depended upon the flow characteristics of the soil. In Shano silt loam in which the water moved readily, water distribution was nearly uniform with depth and did not change time. In soils in which water moved slowly, either because of slow internal water movement when wet (Ritzville loam) or low unsaturated conductivities at relatively low suctions (Sagehill sand), the upper soil became wetter while the lower soil water decreased by a corresponding amount. With the soil profile initially wet, several weeks of deficit irrigation passed before surface soil water content changed markedly.

75:020-055
TWO-DIMENSIONAL TRANSPORT OF SOLUTES DURING NONSTEADY INFILTRATION FROM A TRICKLE SOURCE,
Bresler, E.
Volcani Institute of Agricultural Research, Bet Dagan (Israel).
Soil Science Society of America Proceedings, Vol. 39, No. 4, p 604-613, July-August 1975. 3 fig, 15 ref, 1 append.

Descriptors: *Solutes, *Unsteady flow, *Diffusion, *Convection, *Infiltration, Mathematical models, Numerical analysis, Equations, Unsaturated flow, Salinity, Root zone, Darcys law, Soil moisture, Moisture content, Soil water movement, Soils, Loam, Sands, Evaporation.

A simulation model for analyzing multidimensional simultaneous transfer of a noninteracting solute and water, applicable to infiltration from a trickle source, was developed. The equations describing transient two-dimensional transport of a solute by diffusion and convection in unsaturated porous media were solved numerically by an approach that eliminated the effect of numerical dispersion. The noniterative alternating-direction-implicit finite difference procedure was used. Two mathematical models were considered: (1) a plane flow model involving the Cartesian coordinates x and z, and (2) an axisymmetric flow model described by the cylindrical coordinates r and z. An example of transport in a homogeneous, isotropic and stable sand and loam soil systems was given. Results were shown for typical cases of trickle infiltration to demonstrate the effects of trickle discharge and soil-hydraulic properties on the pattern of salt distribution in the wetted soil zone. The numerical results showed that the approach presented may be useful in analyzing two-dimensional solute transport processes in soils.

75:020-056
DESIGN AND USE OF CLOSED-TOP INFILTROMETERS,
Dixon, R.M.
Agricultural Research Service, Tucson, Arizona. Southwest Watershed Research Center.
Soil Science Society of America Proceedings, Vol. 39, No. 4, p 755-763, July-August 1975. 8 fig, 14 ref.

Descriptors: *Infiltrometers, *Pressure, Surface waters, Pressure head, Infiltration rates, Porous media, Heterogeneity, Air-earth interfaces, Soils, Data collections, Design, Border irrigation, Loam, Saturation, Soil management, Watershed management, Measurement, Soil surfaces, Boundaries(Surfaces).

Several similar closed-top infiltrometers were designed and used to simulated effective surface heads ranging from minus 3 to plus 1 cm of water. Design was based on the principle that natural positive soil air pressure may be simulated by creating an equivalent negative air pressure above ponded surface water. Effective surface head h sub e, defined as the difference between the ponded water depth h sub w, and either the actual or simulated soil air pressure head h sub a, is negative when h sub a is greater than h sub w. Under natural field conditions, negative h sub e often caused counterflow of soil air during water infiltration. Narrow ranges in h sub e surrounding zero greatly affect infiltration by controlling air and water flow in soil macropores and weakly hydrophilic micropores. Thirty-minute cumulative infiltration increased 19% per centimeter increase in h sub e for one soil and 13% per centimeter for another soil. Closed-top infiltrometers make possible realistic infiltration measurements under the negative h sub a commonly produced by rain and irrigation waters as they infiltrate natural soils. These devices may also be useful in studying the infiltration effects of several interacting parameters that are related to h sub e, including soil surface macroporosity and roughness, macropore space extent and continuity, antecedent soil air and water, surface wettability and water repellency, wetted surface area and shape, and surface crust and slope.

75:02G-057
HYDRAULIC CONDUCTIVITY CALCULATIONS FOR UNSATURATED STEADY-STATE AND TRANSIENT-STATE FLOW IN SAND,
Elzeftawy, A., Mansell, R.S.
Florida University, Gainesville. Department of Soil Science.
Soil Science Society of America Proceedings, Vol. 39, No. 4, p 599-603, July-August 1975. 5 fig, 2 tab, 25 ref.

Descriptors: *Hydraulic conductivity, *Unsaturated flow, *Steady flow, *Unsteady flow, Sands, Moisture content, Soil water movement, Pore pressure, Nuclear moisture meters, Tensiometers, Pressure head, Cores, Laboratory tests, Soil density, Infiltration, Depth, Drainage.

Using a method employed by Green and Corey (1971), hydraulic conductivity was calculated as a function of water content for Lakeland fine sand. A gamma ray transmission method for measuring soil water content and a tensiometer-pressure transducer arrangement for measuring soil water suction were also used to experimentally determine values of hydraulic conductivity for a similar range of soil water contents in undisturbed soil cores and hand-packed soil columns. Measured and calculated values were in good agreement for steady flow. During transient flow soil water content was observed to be a non-unique function of suction for water desorption, but depended upon the state of flow. Higher water contents were found at a given pressure head during unsteady flow than during steady flow or static equilibrium (zero flow). Graphs of water content versus soil water suction were similar for cases of steady and no-flow conditions. For transient flow, the soil-water pressure depended upon the soil-water content and rate of change of pressure head with time.

75:02G-058
LINEAR DISPERSION IN FINITE COLUMNS,
Parlange, J.-Y., Starr, J.L.
Connecticut Agricultural Experiment Station, New Haven.
Soil Science Society of America Proceedings, Vol. 39, No. 5, p 817-819, September-October 1975. 2 fig, 6 ref.

Descriptors: *Dispersion, *Solutes, *Soil water movement, Profiles, Boundary processes, Equations, Mathematical models, Soil moisture, Pore water, Velocity.

The effect of the finite length of a soil column on the miscible displacement of a solute was analyzed. The boundary conditions at both ends of the column affected the breakthrough curve, while only the boundary condition at the entrance of the column affected the profile within the column to any extent. The interaction between boundary conditions and column length was such that while the breakthrough curve is essentially that given by the standard solution for a semi-infinite column, even for relatively short columns, the concentration profile was greatly affected by the finite length of the soil column.

75:02G-059
RELATIONSHIPS BETWEEN THE HYDRAULIC CONDUCTANCE OF SURFACE CRUSTS AND SOIL MANAGEMENT IN A TYPIC HAPLUDALF,
Falayi, O., Bouma, J.
Soil Survey Institute, Wageningen (Netherlands).
Soil Science Society of America Proceedings, Vol. 39, No. 5, p 957-963, September-October 1975. 8 fig, 3 tab, 36 ref.

Descriptors: *Hydraulic conductivity, *Soil management, Runoff, Soil erosion, Cultivation, Rotations, On-site investigations, Simulated rainfall, Soil aggregates, Soil properties, Infiltration, Loam, Equipment, Storage, Pores, Corn(Field), Steady flow.

The effect of different soil management, in terms of soil tillage and crop rotation, on soil crusting was investigated by applying continuous artificial rain (6.5 cm/hr) to experimental plots until steady-state conditions were reached. Comparisons were made with bare plots subjected to natural rainfall for a period of 4 months. Significant differences in soil roughness between the plow only and the plow, disk, and harrow treatments resulted in higher infiltration and longer times to incipient runoff for the plow treatment. However, differences in surface roughness and infiltration and runoff rates were insignificant among treatments when steady-state conditions were reached after only 2 hours. Crust conductances, measured in situ, were significantly lower in the plow, disk, and harrow treatments for the sod as compared with the continuous corn rotation. Crusts had a significantly higher conductance when formed on top of clods as compared with crusts formed between clods in the plow treatment. Conductances of crusts formed under short-term high-energy experimental rainfall were not significantly different from those formed under natural conditions, the latter characterized by intermittent low-energy rainfall during a 4-month period. However, their morphology was significantly different.

75:02G-060
DYNAMIC SIMULATION OF WATER STORAGE IN FALLOW SOIL AS AFFECTED BY MULCH OF HYDROPHOBIC AGGREGATES,
Hillel, D., van Bavel, C.H.M., Talpaz, H.
Texas A and M University, College Station. Department of Soil and Crop Sciences; and Texas Agricultural Experiment Station, College Station.
Soil Science Society of America Proceedings, Vol. 39, No. 5, p 826-833, September-October 1975. 7 fig, 1 tab, 16 ref, 1 append.

Descriptors: *Dynamic programming, *Storage, *Fallowing, *Mulching, *Soil aggregates, Numerical analysis, Water balance, Cycles, Infiltration, Evaporation, Soil properties, Hydraulic properties, Rainfall intensity, Runoff, Agricultural runoff, Drainage, Moisture content, Soil moisture, Water conservation, Soil management, Water management(Applied), Crop production, Groundwater recharge, Model studies.

A mechanistic numerical model, based on fundamental physical principles and written in IBM S/360 CSMP language, was designed to compute the dynamic balance of water in a fallow soil through repeated cycles of infiltration and evaporation. The necessary inputs are: (1) hydraulic characteristics of the soil and of the surface crust of mulch layer, (2) duration and intensity characteristics of rainstorms or irrigations, and (3) the potential evaporation rate as it varies diurnally and from day to day. The output provides time-dependent rates and cumulative quantities of infiltration, runoff, surface detention, evaporation, internal drainage and changes in water content of different layers and of the profile as a whole. Computations carried out for a 4-day simulation (including two rainstorms and four evaporation cycles) illustrated the use of the model for uniform, crusted or mulched soil and predicted that the presence of a mulch of hydrophobic aggregates, several centimeters thick, can greatly increase the quantity of water absorbed and retained in the profile. This finding accorded with previously-published experimental results and indicated a promising approach to soil management for water conservation in dryland and irrigated farming.

75:02G-061
DEFLECTION-STIFFNESS CHARACTERISTICS OF CORRUGATED PLASTIC TUBING,
Schwab, G.O., Drablos, C.J.W.
Ohio Agricultural Research and Development Center, Columbus, Ohio.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, December 15-18, 1975. Chicago, Illinois. 11 pg, 2 fig, 4 tab, 8 ref.

Descriptors: *Plastics, *Plastic deformation, *Plastic pipes, Drainage, Drainage practices, Equipment, Pipes.

Deflection of corrugated plastic tubing from replicated field tests and from farm installations in Ohio, Indiana, and Illinois was measured after one to four years following installation. Commercial tubing sizes varied from 102 to 381 mm (4 to 15 in.) in diameter. The purpose of this study was to confirm present standards and to collect supporting data for development of standards for large-size tubing. In the replicated tests from two manufacturers 102-mm (4-in.) tubing deflection decreased nearly linearly with an increase in stiffness. Maximum deflections after 4 years were less than 17 per cent. All but one test sample was below ASTM F405-74 stiffness standards. About 80 per cent of the deflection occurred during the first two years with essentially no difference between the third and fourth year. Average differences in deflection for 60- and 120-degree groove angles were within 2 mm (0.08 in.) or less than the accuracy of measurement.

75:020-062
PREDICTED VERSUS MEASURED DRAINABLE POROSITIES,
Skaggs, R.W., Wells, L.G., Ghate, S.R.
North Carolina State University, Raleigh, 27607.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, December 15-18, 1975, Chicago, Illinois, 20 p; 8 fig; 1 tab; 9 ref.

Descriptors: *Drainage engineering, *Drainage practices, Drains, Soil water, Soil water movement, Cores, Soil tests, Soil investigations.

Experiments were conducted on large field cores to determine the relationship between drainage volume and water table depth for five soils. The measured drainage volumes were less than predicted from the soil water characteristics for all but one soil, for which measured and predicted results were in good agreement. Drainable porosities were calculated from both theoretical and experimental drainage volume-water table depth relationships by assuming that the unsaturated zone is essentially 'drain to equilibrium' to the water table. The experimental drainable porosities thus obtained were less than observed.

75:020-063
AN EXPERIMENT WITH A LINEARLY INCREASING SPACING OF SUBSURFACE DRAINS,
Broughton, R.S., Tu, C.K-W.
McGill University, Macdonald Campus at Sainte Anne de Bellevue, Quebec, Canada H0A 1C0.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, December 15-18, 1975, Chicago, Illinois, 21 p; 9 fig; 3 tab; 10 ref.

Descriptors: *Drainage, *Drainage effects, *Drainage practices, *Drainage systems, Crop response, Soil water, Soil water movement.

Subsurface drainage systems with diagonal drains between parallel drains were installed to give spacings varying continuously 6 to 60m on a minimum of land. Three drain depth replicates were used. Indications of the effects of depth and spacing of drains on water table depths, maize yields and soil trafficability were provided.

75:020-064
EFFECT OF OPENINGS ON INFLOW INTO CORRUGATED DRAINS,
Bravo, M.J., Schwab, G.O.
The Ohio State University, Columbus, Ohio, Ohio Agricultural Research and Development Center.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, December 15-18, 1975, Chicago, Illinois, 11 p; 6 fig; 3 tab; 11 ref.

Descriptors: *Orifices, *Orifice flow, *Drainage, *Drainage engineering, *Drainage practices, Mathematical models, Model studies.

The relative effectiveness of the openings in corrugated plastic drains, as influenced by the presence of soil within the corrugations and within the openings themselves was evaluated from the standpoint of water inflow for saturated conditions in a homogeneous, isotropic soil using a three-dimensional electric analog and mathematical models.

75:020-065
SOIL MOISTURE REGIME WITH SUBIRRIGATION,
Valderuten, R., Ligon, J.T., Lambert, J.R.
University del Valle, Cali, Colombia.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, December 15-18, 1975. Chicago, Illinois. 20 p, 14 fig, 18 ref.

Descriptors: *Soil moisture, *Irrigation, *Subsurface irrigation, *Model studies, Simulation analysis, Soil-water-plant relationships, Climatic data.

A simulation model was developed to predict the soil moisture regime with subirrigation. Conclusions drawn from the performance of the model are state as follows: a) the simulation model incorporating some plant physical characteristics, soil and water properties, and climatic variables, gave reasonable results; b) the physical process of water movement from the water table through the root system under subirrigation conditions is highly related to the evaporative losses at the surface; c) water uptake by the root system is influenced by the root distribution and by the hydraulic characteristics of the soil; d) a relatively small portion of the roots located in the vicinity of the water table are responsible for a large part of the water uptake; and e) further studies involving a fluctuating water table in heterogenous soils are needed to obtain a simulation model more representative of the actual case.

75:020-066
LEAF WATER POTENTIAL AND MOISTURE BALANCE--FIELD DATA,
Huck, M.G., Browning, V.D., Young, R.E.
Agricultural Engineering Department, Agricultural Experiment Station, Auburn, Alabama.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, December 15-18, 1975. Chicago, Illinois. 15 p, 6 fig, 3 tab, 13 ref.

Descriptors: *Root development, *Root distribution, *Root system, Soil moisture, Soil water, Soil-water-plant relationships, Irrigation, Irrigation practices, Transpiration.

The experimental hypothesis stated at the outset that increased root growth in a larger soil reservoir will make additional water available to the plant was tested and largely proved to be true. However, the corollary, based on a suggestion that increased water potential will permit a more rapid growth of cotton plants, has been cast into serious doubt. If the osmotic component of leaf water potential is neglected, the accumulated data from 3 years of field experiments strongly suggest that plants growing under these conditions have a slightly lower leaf water potential when the availability of additional soil water permits growth of a larger plant with a higher transpirational demand.

75:020-067
PLANT WATER STRESS CRITERIA FOR IRRIGATION SCHEDULING,
Stegman, E.C., Schiele, L.H., Bauer, A.
Agricultural Engineering Department, North Dakota State University, Fargo, North Dakota.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, December 15-18, 1975, Chicago, Illinois 22 p, 7 fig, 4 tab, 18 ref.

Descriptors: *Soil water, *Soil moisture, *Soil-water-plant relationships Scheduling, Crop response, Plant physiology, Plant tissues, Stress, Stress analysis, Irrigation, Irrigation effect.

This study was conducted to determine the potential for relating plant water stress development to variables indicative of prevailing soil and atmospheric environments. Given such relationships irrigation scheduling services should be better able to use plant stress oriented criteria for determining when to irrigate. Stress development was evaluated by leaf xylem pressure and stomatal diffusion resistance measurements. Data sets were obtained for 4 to 5 crops at two Irrigation Branch Stations in North Dakota. The two sites provided soil types with differing hydraulic properties and available water holding capacities. Leaf xylem pressure data for each crop-soil combination were correlated by regression procedures with ambient air temperatures and root zone soil moisture content. Subsequent application of these xylem pressure levels as critical limits to each regression model permitted estimation of allowable root zone soil moisture depletion relative to expected ambient air temperatures. This procedure offers a method for interpreting water balance estimates of soil moisture deficit and advance forecasts of daily maximum air temperatures for need of irrigation.

75:020-068
STABILITY ANALYSIS OF INFILTRATION,
Philip, J.R.
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia), Division of Environmental Mechanics.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1042-1049, November-December 1975. 1 tab, 21 ref, 1 append.

Descriptors: *Infiltration, *Stability, Mathematical studies, *Equations, *Seepage, Gravitational water, Infiltration rates, Movement, Percolation, Ponding, Soil moisture, Soil water movement, Unsaturated flows, Laboratory tests, Hydrodynamics, Model studies, Water pressure, Soils.

A rigorous hydrodynamic stability analysis of the delta-function model of infiltration was developed. Raats recently proposed as the criterion for instability that wetting front velocity should increase with front penetration. This detailed analysis, on the other hand, showed that the fundamental criterion is that the water pressure gradient immediately behind the front should oppose the flow. The two criteria agree only in the special case where five significant parameters of the system are all constant and independent of depth, or of depth to the front. The Raats criterion fails in the various more general cases with one or more of these quantities variable. Care should be exercised in applying results for the delta-function model to flows with gradual wetting fronts, especially when nonwetting strata are involved.

75:020-069
REDOX POTENTIAL IN IRRIGATED DESERT SOILS AS AN INDICATOR OF AERATION STATUS,
Meek, B.D., Grass, L.B.
Imperial Valley Conservation Research Center, Brawley, California.
Soil Science Society of America Proceedings, Vol. 39, No. 5, p 870-875, Sept-Oct. 1975. 10 fig, 3 tab, 15 ref.

Descriptors: *Oxidation-reduction potential, *Irrigation effects, *Soil-water-plant relationships, *Sierozems, Sprinkler irrigation, Flood irrigation, Soil moisture, Soil microorganisms, Arid lands, Environmental effects, Soil temperature, Soil tests, Aeration.

Six experiments were designed to evaluate the effects of temperature, flooding time, soil water content, and energy source on the redox potential (Eh) of irrigated desert soils. Field heterogeneity required the use of 10 to 20 electrodes placed in a 30-cm square to characterize a treatment. Eh varied over a short distance, with no effects due to poisoning or erratic electrode readings; a 5 C temperature increase at the 15-cm depth caused a 50-mV drop in redox potential. Soil saturation time correlated directly with Eh decline; Eh decreased less during drip or sprinkler irrigation than when soil was flooded. To lower Eh, soil moisture must be increased beyond a critical value to seal the surface to atmospheric oxygen. Measurement of the oxygen diffusion rate and quantities of iron or manganese in the soil solution will aid determination of the soil's aeration status.

75:020-070
A WATER MANAGEMENT MODEL FOR HIGH WATER TABLE SOILS,
Skaggs, R.W.
North Carolina State University, Raleigh, 27607.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, December 15-18, 1975. Chicago, Illinois. 27 p, 9 fig, 1 tab, 20 ref.

Descriptors: *Water management, *Computer model, *Model studies, Soil water.

A water management computer model is being developed to simulate the soil water regime for high water table soils. The model is based on a water balance in the soil profile. Approximate methods are used to evaluate infiltration, subsurface drainage, ET, subirrigation, and the soil water distribution within the profile. Inputs to the model are soil properties, parameters of the surface and subsurface drainage systems, and meteorological data. The model provides the capability of predicting the response of the water table and the soil water regime above the water table to rainfall, ET, given degrees of surface and subsurface drainage, and the use of water table control or subirrigation practices. When finally tested and completed the model can be employed to evaluate alternative water management systems and operational procedures by simulating their performance over several years of record. Results of a field experiment to test the validity of the model are presented. Examples of the use of the model for water management system design and evaluation are given.

75:020-071
EFFECT OF AGRICULTURAL DRAINAGE ON WATER QUALITY,
Smolen, M.D., Rasnake, M., Shanholtz, V.O.
Virginia Polytechnic Institute and State University, Southern Piedmont Center and Department of Agricultural Engineering, Blackstone, Virginia.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, December 15-18, 1975, Chicago, Illinois. 9 p, 5 fig, 4 ref.

Descriptors: *Return flow, *Drainage, Water quality, Water pollution, Model studies, Water chemistry, Nitrogen, Nitrates, Irrigation effects.

Presentation of preliminary results from a modeling and monitoring study which compares chemical quality data from adjacent agricultural and non-agricultural areas. Increased levels of nitrate-nitrogen were detected in field draining streams following the first period of agricultural activity. Results are discussed in terms of a planned comprehensive chemical transport study.

75:020-072
MODELING SOIL WATER MOVEMENT FOR TRICKLE IRRIGATION,
Warrick, A.W., Lomen, D.O.
Arizona University, Tucson. Department of Soils, Water and Engineering.
Available from the National Technical Information Service, Springfield, Va. 22161 as PB-248 049, $3.50 in paper copy, $2.25 in microfiche. Project Completion Report, October 1975. 17 p, 14 fig, 3 tab, 21 ref.

Descriptors: *Unsaturated flow, Irrigation, *Soil water movement, Equations, Evapotranspiration, Model studies, *Soil moisture, Flow rates, *Arizona, Flow measurement, Measurement, *Mathematical models.

Solutions of the time dependent linearized soil moisture flow equation have been completed for point, line, strip, disc and ring sources. These solutions were used to simulate time dependent moisture regimes for various geometries used in trickle irrigation. They are also useful as a check for elaborate finite difference or finite element schemes for solving the non-linear moisture flow equations. For one-dimensional steady state flow, analytical solutions were obtained for seven types of plant water withdrawal functions depending on the flux potential as well as the depth below the surface. The solution of the linearized moisture flow equations with a point source has been compared with the finite difference solution of the non-linear equations of Brandt et al. as well as with field data measured on sandy soil in Yuma and the Sinai. These comparisons were very favorable but demonstrated that care must be taken in applying the model to problems involving large fluctuations in moisture content. Two field experiments for measuring evapotranspiration under trickle irrigation were made in citrus groves near Yuma. The objectives of these measurements were to study the water uptake distribution in the close vicinity of a tree and the microclimate of a grove under trickle irrigation. Data obtained during these field trips will be used to analyze the irrigation policy of the farmers in Yuma and to compare with the predictions of the corresponding mathematical models.

75:020-073
THE CALCULATION OF STEADY-STATE WATER-TABLE HEIGHTS IN DRAINED SOILS BY MEANS OF THE FINITE-ELEMENT METHOD,
Gureghian, A.B., Youngs, E.G.
Cambridge University, (England). Department of Applied Biology.
Journal of Hydrology, Vol. 27, No. 1/2, p 15-32, October 1975. 13 fig, 1 tab, 10 ref.

Descriptors: *Subsurface drainage, *Soil water, *Finite element analysis, *Mathematical studies, *Numerical analysis, *Water table, Equations, Steady flow, Drains, Drainage systems, Percolation, Soil water movement, Saturated flow, Groundwater, Mathematical models.

The use of a Galerkin-type finite-element method for the solution of steady-state drainage problems in both homogeneous and heterogeneous soils was described. The numerical procedure was shown to give satisfactory water-table heights in particular cases of ditch drainage in uniform and layered soils with given incident rainfall. The use of the method in more complex situations was illustrated with an example of a drained layered soil in which the backfill over a pipe drain created a vertical band of soil of different hydraulic conductivity.

75:020-074
THE WATER TABLE AND THE NEUTRON MOISTURE METER,
Visvalingam, M.
Hull University (England). Department of Geography; and Durham University (England). Department of Geography.
Journal of Hydrology, Vol. 27, No. 3/4, p 331-337, December 1975. 6 fig, 4 ref.

Descriptors: *Water table, *Neutron activation analysis, Neutron absorption, Soil moisture, Saturated soils, Soil profiles, Piezometers, Tubes, Moisture meters, Measurement, On-site investigations, Zone of saturation, Nuclear meters.

Measurements with a neutron meter were conducted in the University of Hull Catchwater Catchment in East Yorkshire, close to the Hydrological Station at Westlands. A tile drained plot, 50 ft square, with a relative relief of less than 1 ft, was selected in a boulder-clay site under pasture. Instrumentation included access tubes for the neutron probe and well-point techniques, such as piezometers and cased auger holes using polyvinyl chloride (PVC) tubes. The meter was manufactured by Nuclear Enterprises (G.B.) Ltd. The 21.5 in long moisture probe, 1.5 in in diameter, consisted of a 10-mCi241 Am-Be source, side placed on a BF sub 3 proportional counter. The aluminum-alloy access tubes used were a standard 6 ft in length. They were driven into slightly undersized auger holes, leaving 6 in protruding above the surface. Measurements showed count rates at capillary saturation to be within the error limits of count rates at full saturation. However, the saturation profiles in themselves indicated not only the zonation of the soil but also differences in drainable porosity.

75:020-075
WATER MOVEMENT WITHIN THE ROOT ZONE OF IRRIGATED AND NONIRRIGATED GRAIN SORGHUM,
Stone, L.R., Horton, M.L.
South Dakota State University, Brookings. Department of Plant Science.
Journal of Soil and Water Conservation, Vol. 30, No. 6, p 283-286, November-

December 1975. 3 Fig, 7 ref.

Descriptors: *Soil water movement, *Root zone, *Grain sorghum, *Irrigation, Solutes, Nutrients, Grains(Crops), Unsaturated flow, Evapotranspiration, Loam, Tensiometers, Potentiometric level, Hydraulic conductivity, Darcys Law, Depth, Salts, Soil profiles, Perched water.

Water movement and redistribution are important in supplying nutrients and water to plants. Water movement and redistribution during August 1972 in fields of irrigated and nonirrigated grain sorghum were determined. Soil water flux in the non-irrigated area was upward in all soil-depth intervals during the study. Upward flux in the 15- to 30-, 30- to 50-, and 50- to 70- cm depths decreased with time. Upward flux in the 130- to 150-cm depth reached a maximum of 0.17 cm per day and then remained near 0.11 cm per day. Immediately after irrigation, flux was downward in all soil depth intervals in the irrigated sorghum. Flux in the 130- to 150-cm depth remained downward. Flux in the 15- to 30-, 30- to 50-, and 50- to 70-cm depths turned upward within one week after irrigation.

75:02G-076
A PROCEDURE FOR THE SAMPLING AND TESTING OF LARGE SOIL CORES,
Watson, K.K., Lees, S.J.
Soil Science of America Proceedings, Vol. 39, No. 3, p 589-590, May-June 1975.
1 Fig, 5 ref.

Descriptors: *Soil water, *Computer models, Soil properties, Soil investigations, Soil moisture, Soil tests, Laboratory test.

The significance of acquiring reliable data on the soil-water characteristics of field soils is discussed in relation to the input requirements of computer-based numerical models of the unsaturated flow process. A specification outlining the conditions to be fulfilled in sampling and testing a large soil core is then detailed. Equipment used in extracting a 30-cm-diam soil core is described together with relevant laboratory instrumentation.

75:02G-077
ANNOTATED BIBLIOGRAPHY ON TRICKLE IRRIGATION,
Smith, S.W., Walker, W.R.
Colorado State University, Fort Collins, Colorado.
Agricultural Engineering Department, Environmental Resources Center.
Information Series No. 16, June 1975. 61 p.
(See 75:03F-019)

75:02G-078
PERFORMANCE AND EVALUATION OF COMBINED MOLE-TILE DRAIN SYSTEM IN HEAVY SOILS,
Unhanand, K., Tuamsangian, P.
Utah State University, Logan, Utah.
International Commission On Irrigation and Drainage Bulletin, p 38-52, January 1975. 24 Fig, 8 equ, 15 ref.

Descriptors: *Drainage, *Drainage effects, *Drainage practices, *Drainage system, *Drains, Soils, Soil water.

A field experiment was conducted to investigate the performance and cost of the combined mole-drain systems in heavy soils in comparison with a similar tile drain system. Three experimental plots consisted of a tile-drained plot, a combined (single mole) drained plot and a combined (double mole) drained plot. They were constructed with a tile drain spacing of 37 metres (120 feet) and a mole drain spacing of 1.83 metres (6 feet). The experimental results show that the combined systems were more effective than the drain system in lowering the water table. The difference in the effectiveness of the single mole drains and double mole drains was not distinctly apparent. No deterioration of the mole drains during the period of two years tested was detected. The cost analysis indicated that the annual cost of the combined systems is always less than that of an equivalent tile drain system even if the mole drains in the combined system have to be redrawn every year.

75:020-079
A NUMERICAL MODEL FOR THE SIMULATION OF UNSATURATED VERTICAL FLOW OF MOISTURE IN SOILS.
Wind, G.P., Van Doorne, W.
Institute for Land and Water Management Research, Wageningen (The Netherlands).
Journal of Hydrology, Vol. 24, p 1-20, 1975. 3 fig, 4 tab, 19 equ, 6 ref.

Descriptors: *Model studies, *Mathematical models, *Soil water movement, *Soil moisture, Soil investigations, Irrigation.

This paper describes a digital model for the simulation of non-steady unsaturated vertical flow of moisture in soils. By using an integrated formula for flow velocity, errors due to averaging two conductivity values are avoided. This confines the applicability to situations in which the soil is not too dry. The model also simulates the drainage process. So it produces the depth of the groundwater table and the discharge data. Other output data are pond depth, runoff, flow velocity at every depth, moisture content and tension for every layer. A discussion is given on the errors caused by averaging conductivity values in models. A chapter is dealing with oscillations caused by too large time steps. The time steps must be chosen in such a way that errors will not be amplified but reduced. The last chapter gives the costs of computation. For soils with low permeability the model seems to be very cheap to run. A digital model as the one described is fit for short runs with many soils. For long runs with one soil an analogous model is more appropriate.

75:020-080
THE OCCURRENCE AND REMOVAL OF NITROGEN IN SUBSURFACE AGRICULTURAL DRAINAGE FROM THE SAN JOAQUIN VALLEY.
Brown, R.L.
California Department of Water Resources, Sacramento, California, 95814.
Water Research Vol. 9, No. 5/6, p 529-546, May-June 1975. 11 fig, 7 tab, 39 ref.

Descriptors: *Drainage, *Drainage effects, *Water treatment, *California, *Nitrogen, Waste water treatment, Water pollution, Return flow.

During the years 1967-1973 there have been extensive studies of subsurface agricultural drainage in the San Joaquin Valley of California. These studies, by cooperating state and federal agencies, were to determine the composition and quantity of drainage waters produced from irrigated agriculture, to evaluate possible methods of removing problem constituents (mainly nitrogen) from these waters, and to obtain an idea of the effectiveness of the treatment methods studied for reducing the waters' biostimulatory content with respect to potential receiving waters.

75:020-081
INTERACTIONS BETWEEN ORGANIC COMPOUNDS, MINERALS, AND IONS IN VOLCANIC ASH DERIVED SOILS: I. ADSORPTION OF BENZOATE, P-OH BENZOATE, SALICYLATE, AND PHTHALATE IONS.
Appelt, H., Coleman, N.T., Pratt, P.F.
Soil Science Society of America Proceedings, Vol. 39, No. 4, p 623-627, July-August 1975. 4 fig, 4 tab, 15 ref.

Descriptors: *Ions, *Organic compounds, *Adsorption, Soils, Soil investigations.

The adsorption, desorption, and competitive adsorption characteristics of benzoate p-OH benzoate, salicylate, and phthalate were used as models to study the possible mechanisms involved in the interactions of organic compounds with amorphous materials. The studies were carried out in batch systems using subsoil samples of three Typic Dystrandept soils from Chile.

75:02G-082
AMMONIA VOLATILIZATION FROM SURFACE APPLICATIONS OF AMMONIUM COMPOUNDS ON CALCAREOUS SOILS: IV. EFFECT OF CALCIUM CARBONATE CONTENT,
Fenn, L.B., Kissel, D.E.
Texas A&M Agriculture Research Center, El Paso, 79927.
Soil Science Society of America Proceedings, Vol. 39, No. 4, p 631-633, July-August 1975. 3 fig; 7 tab, 5 ref.

Descriptors: *Ammonia, *Calcium carbonate, *Nitrogen, *Fertilizers, *Fertilization, Soils.

The purpose of this study was to determine the effect of soil CaCO3 content on ammonia volatilization from surface applied ammonium compounds. Ammonia-nitrogen losses from surface-applied (NH4)2SO4 increased rapidly to 6.1% soil CaCO3, with slight NH3 loss increases from 6.1 to 9.7% soil CaCO3, and no NH3 loss increase beyond 9.7% soil CaCO3. Ammonium nitrate reached maximum NH3-N loss at 1.3% soil CaCO3 and 110 kg NH4+-N/ha, with lower but still increasing losses of NH3-N at 6.1% soil CaCO3 and 550 kg NH4+N/ha.

75:02G-083
THE EFFECT OF SOIL PROPERTIES ON ZINC ADSORPTION BY SOILS,
Shuman, L.M.
Georgia University, Agricultural Experiment Stations, Experiment, Ga. 30212.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 454-458 May-June, 1975. 4 fig, 2 tab, 18 ref.

Descriptors: *Zinc, *Organic matter, *Clays, *Soils, *Soil investigations, *Sands, Soil Chemistry, Soil texture.

Solutions containing eight different concentrations of Zn were equilibrated with four soils sampled at two depths to determine whether Zn adsorption conformed to the Langmuir isotherm and to relate the Langmuir coefficients to soil properties. Zinc adsorption conformed to the Langmuir isotherm and two linear portions of the curve were found. The adsorption sites for the lower part had very high bonding energy coefficients and low adsorptive capacities compared with the adsorption sites of the part of the curve corresponding to higher Zn concentrations in the equilibrating solution. The CEC was related to the adsorptive capacity. The lower part was equivalent to 23% of the CEC and the upper part to 76% of the CEC. Soils high in clay or organic matter had higher adsorptive capacities and higher bonding energies for Zn than sandy soils low in organic matter. More differences in Zn adsorption were observed among soil types than between depths in each soil type. A study of the effect of pH on the adsorption of Zn revealed that low pH reduced Zn adsorption more for the sandy soils than for those high in colloidal-size materials.

75:02G-084
VARIATIONS IN PICLORAM LEACHING PATTERNS FOR SEVERAL SOILS,
Ping, C.L., Cheng, H.H., McNeal, B.L.
Washington State University, Pullman 99163.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 470-473, May-June 1975. 3 fig, 2 tab, 9 ref.

Descriptors: *Leaching, Soils, Soil investigations, Soil texture, Pesticides, Diffusion.

Laboratory studies of picloram leaching under saturated conditions were conducted for four soils. Leaching patterns could be related to variations in soil texture and pore uniformity for three soils from arid and semiarid regions. Diffusion from conducting pores into adjacent micropores appeared to be the most plausible explanation of leaching patterns obtained for an Oxisol of volcanic origin from Hawaii. Evidence supporting the presence of the postulated micropore structure in this tropical soil was obtained from constancy in flow rate, from scanning electron micrographs, and from picloram recovery at a reduced leaching rate.

75:020-085
EFFECT OF HYSTERESIS ON THE PREDICTION OF INFILTRATION, REDISTRIBUTION AND DRAINAGE OF WATER IN A LAYERED SOIL,
Dane, J.H., Wierenga, P.J.
Colorado State University, Fort Collins, Colorado. Department of Agronomy.
Journal of Hydrology, Vol. 25, p 229-242, 1975. 18 fig, 2 tab, 18 ref.

Descriptors: *Hysteresis, *Soil water movement, *Infiltration, Infiltration rates, Drainage, Soil water.

In order to study the effect of hysteresis on soil water movement a large soil column, filled with Glendale clay loam over a river sand, was flood-irrigated with 10 cm water. The infiltration rate, wetting front advance, water content redistribution, and the amount of drainage water was measured. A computer model, using S/360 CSMP, was developed to simulate the flow behavior. The main drying and main wetting curves in the soil water tension-water content, and in the hydraulic conductivity-water content relationships were provided in the computer model. From these relationships, scanning curves were developed to simulate hysteretic flow behavior under both wetting and drying conditions. Experimental data were compared with data computed from either the main drying, the main wetting, or the scanning curves. Infiltration was accurately predicted using the main wetting curves. However, redistribution and drainage were better predicted when hysteresis was taken into account.

75:020-086
DESCRIPTION OF WATER AND AIR MOVEMENT DURING INFILTRATION,
Brustkern, R.L., Morel-Seytoux, H.J.
Montana State University, Bozeman, Montana. Department of Civil Engineering.
Journal of Hydrology, Vol. 24, p 21-35, 1975. 10 fig, 12 equ, 4 ref.

Descriptors: *Infiltration, *Mathematical studies, Soil water movement, Porous media, Capillary water.

An approximate analytical solution for the problem of one-dimensional infiltration into a homogeneous porous medium is presented. The solution is made possible by assuming that capillary pressure can be partially neglected. Two equations involving two unknowns, water saturation and total velocity, are derived and then solved in a step-wise fashion to yield the saturation profile and the total velocity at any time. Infiltration quantities are obtained by integration of the area under the saturation profile. Analytical concepts and procedures relevant to the determination of the evolving saturation profile are discussed in some detail. Particular attention is given to the nature and behavior of the fractional flow function. The occurence of air counterflow during infiltration is also discussed.

75:020-087
THE EFFECT OF PERMEABLE SURROUNDS ON THE PERFORMANCE OF CLAY FIELD DRAINAGE PIPES,
Dennis, C.W., Trafford, B.D.
Field Drainage Experimental Unit, Anstey Hall, Trumpington, Cambridge (Great Britain).
Journal of Hydrology, Vol. 24, p 239-249, 1975. 7 fig, 2 tab, 4 equ, 18 ref.

Descriptors: *Drainage, *Drains, *Drainage effects, Drainage design, Soil water, Soil water movement.

The relative performances of a plain clayware drain and ones with a partial and a complete gravel surround were investigated by measuring the drain discharge rate from each during ponded conditions when installed in a sand tank. From the drain discharge the effective radius of each drain installation was calculated and these values used in the hodograph solution of the drainage problem to obtain steady state theoretical relationships between water-table height and drain discharge. Comparison of the values with those observed in experiments in the sand tank revealed reasonable agreement.

75:020-088
THE EFFECT OF THE DEPTH OF AN IMPERMEABLE BARRIER ON WATER-TABLE HEIGHTS IN DRAINED HOMOGENEOUS SOILS,
Youngs, E.G.
Agricultural Research Council, Unit of Soil Physics, Cambridge (Great Britain).
Journal of Hydrology, Vol. 24, p 281-290, 1975. 5 fig, 12 equ, 13 ref.

Descriptors: *Impervious membranes, Soils, Water table, Drainage, Drainage effects, Model studies.

The water-table height in a drained homogeneous soil at a given rainfall rate is greater the closer an impermeable barrier is below the drain. Upper and lower limits for the water-table height, between which the true value lies, are estimated from theoretical considerations. These show that the lower the rainfall rate for a given depth of impermeable barrier the greater is the effect on the water-table height. Hydraulic model and electric analogue experiments are in agreement with these results.

75:020-089
RELATIONSHIPS BETWEEN THE DENITRIFICATION CAPACITIES OF SOILS AND TOTAL, WATER-SOLUBLE AND READILY DECOMPOSABLE SOIL ORGANIC MATTER,
Burford, J.R., Bremner, J.M.
Iowa State University, Department of Agronomy. Department of Soil Science, University of Reading, London Road, Reading, Berks RG1 5AQ, England.
Soil Biology & Biochemistry, Vol. 7, No. 6 p 389-394, November 1975. 5 fig, 3 tab, 13 ref.

Descriptors: *Organic matter, *Denitrification, Soils, Soil investigation, Soil chemistry, Nitrogen, Anaerobic conditions.

The relationships between the denitrification capacities of 17 surface soils and the amounts of total organic carbon, mineralisable carbon, and water-soluble organic carbon in these soils were investigated. The soils used differed markedly in pH, texture, and organic-matter content. Denitrification capacity was assessed by determining the N evolved as N2 and N2O on anaerobic incubation of nitrate-treated soil at 20 degrees C for 7 days, and mineralizable carbon was assessed by determining the C evolved as CO2 on aerobic incubation of soil at 20 degrees C for 7 days. The denitrification capacities of the soils studied were significantly correlated with total organic carbon and very highly correlated with water-soluble organic carbon or mineralisable carbon. The amount of nitrate N lost on anaerobic incubation of nitrate-treated soils for 7 days was very closely related to the amount of N evolved as N2 and N2O.

75:020-090
SOIL ORGANIC MATTER FRACTIONS AS SOURCES OF PLANT-AVAILABLE SULPHUR,
Freney, J.R., Melville, G.E., Williams, C.H.
Division of Plant Industry, CSIRO, Canberra, 2601 Australia.
Soil Biology & Biochemistry, Vol. 7, No. 3, p 217-221, May 1975. 1 fig, 5 tab, 21 ref.

Descriptors: *Organic matter, *Sulphur, Soils, Soil investigations, Soil-water-plant relationships.

Pot culture experiments are described which attempt to identify the organic fractions of soil sulphur that decompose during the growing season to provide plant-available sulphur. Soil organic matter was labelled with 35S by incubating soil with labelled sulphate and several organic sulphur fractions were determined before and after the growth of Sorghum vulgare and following a fallow treatment. The effect of moisture stress on the uptake of sulphur plants was also investigated; this treatment had little effect.

75:020-091
DISAPPEARANCE OF NITRATE UNDER TRANSIENT CONDITIONS IN COLUMNS OF SOIL,

Doner, H.E.
California University, Berkeley, Department of Soils and Plant Nutrition, Berkeley, California 94720.
Soil Biology & Biochemistry, Vol. 7, No. 4/5, July 1975. p 257-259. 1 fig, 8 ref.

Descriptors: *Nitrate, *Flow rate, Soil investigations, Soil chemistry, Leaching, Soil texture.

Previously a rapid reduction of NO3 was obtained in soil columns with continuous flow, before the establishment of steady state conditions. This initial behavior was not a function of flow rates. In order to determine what influence NO3 concentrations might have on transient and steady state rates, of NO3 loss, small soil columns were infiltrated with 0, 100, and 1000 micrograms ml(-1)NO3-N and the effluents were analysed daily for NO3 and NO2.

75:020-092
SHORT TERM NITRATE LOSSES AND ASSOCIATED MICROBIAL POPULATIONS IN SOIL COLUMNS,
Doner, H.E., Volz, M.G., Belser, L.W., Loken, Jan-Per.
California University, Department of Soils and Plant Nutrition, Berkeley, California 94720.
Soil Biology & Biochemistry, Vol. 7, No. 4/5, p 261-263, July 1975. 1 fig, 15 ref.

Descriptors: *Nitrate, *Leaching, Soil investigations, Soils, Soil tests, Return Flow, Irrigation.

The relationship between NO3 loss from solution and associated microbial populations as a function of time and depth in soil was studied. Soil columns were leached with a NO3 solution under flooded conditions. Soil columns were cut into top, middle and bottom sections following 4.5, 12, 24, 48 and 120 h of leaching. Soil was subsequently analysed for NO3 and NO2 content and microbial counts were made for denitrifiers, nitrate reducers and total microbial population. Nitrate losses were found to be directly related to an increase in the denitrifier population and proportional to the residence time of solution in the soil. The total microbial population and nitrate reducer population remained nearly constant throughout the experiment.

75:020-093
FORMATION OF CHEMICAL AND BIOLOGICAL DENITRIFICATION PRODUCTS IN FLOODED SOIL AT CONTROLLED pH AND REDOX POTENTIAL,
Van Cleemput, O., Patrick, W.H. Jr., McIlhenny, R.C.
Louisiana State University, Agronomy (Soils) Department, Baton Rouge, Louisiana 70803.
Soil Biology & Biochemistry, Vol. 7, No. 4/5, p 329-332, July 1975. 3 fig, 1 tab, 13 ref.

Descriptors: *Denitrification, *Saturated soils, Soils, Soil investigations, Chemical reactions.

The formation of denitrification products was studied in a waterlogged soil which was treated with and without mercuric chloride. Before the addition of the sterilant and NO3-N the pH was controlled at 5, 6 and 8 and the redox potential at 0 and +400 mV in stirred suspensions. Denitrification products N2, N2O and some traces of NO were detected.

75:020-094
TEMPERATURE EFFECTS ON AMMONIFICATION AND NITRIFICATION IN A TROPICAL SOIL,
Myers, R.J.K.
Division of Land Use Research, CSIRO, Canberra, A.C.T., Australia.
Soil Biology & Biochemistry, Vol. 7, No. 2, p 83-86, March 1975. 2 fig, 2 tab, 14 ref.

Descriptors: *Ammonification, *Nitrification, Soils, Soil investigations, Nitrogen, Temperature.

Ammonification of soil organic N and nitrification of ammonium-N was studied in Tindall clay loam over a range of temperatures from 20-60 C. Nitrification rates at each temperature were constant throughout the 28 day incubation, whereas most of the ammonification occurred in the first 7 days.

75:02G-095
EFFECT OF ALTERNATE AEROBIC AND ANAEROBIC CONDITIONS ON REDOX POTENTIAL, ORGANIC MATTER DECOMPOSITION AND NITROGEN LOSS IN A FLOODED SOIL,
Reddy, K.R., Patrick, W.H., Jr.
Louisiana State University, Laboratory of Flooded Soils and Sediments, Department of Agronomy, Baton Rouge, Louisiana 70803.
Soil Biology & Biochemistry Vol. 7, No. 2, p 87-94, March 1975. 6 fig, 1 tab, 25 ref.

Descriptors: *Aerobic conditions, *Anaerobic conditions, Organic matter, Decomposing organic matter, Nitrogen, Nitrate, Denitrification.

The effect of several cycles of varying length of alternate aerobic and anaerobic conditions on redox potential, organic matter decomposition and loss of added and native nitrogen was investigated under laboratory conditions in flooded soil incubated for 128 days. Redox potential decreased rapidly when air was replaced with argon for the short-time cycles, but decreased more slowly where the aerobic period was long enough to permit build-up of nitrate. The minimum redox potential reached during the anaerobic period was generally lower for the longer cycles, but in all cases was low enough for denitrification to occur. Rate of decomposition of organic matter was faster in the treatments with a greater number of alternate aerobic and anaerobic periods.

75:02G-096
MODEL FOR DECOMPOSITION OF ORGANIC MATERIAL BY MICROORGANISMS,
Parnas, H.
Utah State University, Ecology Center, Logan, Utah 84322.
Soil Biology & Biochemistry, Vol. 7, No. 2, p 161-165, March 1975. 8 fig, 1 tab, 29 equ, 11 ref.

Descriptors: *Model studies, *Decomposing organic matter, *Organic matter, Microorganisms, Soil investigations.

A theoretical model which gives the rate of microbial decomposition of organic material (plant or animal residues, or soil organic matter) is presented. Explicit equations for the rate of decomposition, mineralizations, and immobilization are given. The main assumption of the model is that the rate of decomposition of any substrate is proportional to the growth rate of its decomposers. The main results of the model are: 1. Addition of extra nitrogen to materials poor in nitrogen increase their rate of decomposition; 2. Addition of extra nitrogen to a substrate whose initial carbon/nitrogen ratio is above a critical ratio (20-30) causes a decrease in the substrate's carbon/nitrogen ratio during its decomposition; 3. If the initial carbon/nitrogen ratio is below the critical one, no change in the substrate's ratio will occur with time; 4. Net mineralization of organic nitrogen mineralization but not necessarily the rate of net mineralization. All the model results are analytical and independent of the values for the various parameters. Nevertheless the application of the model to real field conditions is discussed while presenting a numerical example.

75:02G-097
EFFECT OF PLOUGHING AND DIRECT DRILLING ON SOIL NITRATE CONTENT,
Dowdell, R.J., Cannell, R.Q.
Agricultural Research Council Letcombe Laboratory, Wantage, Oxon.
Journal of Soil Science, Vol. 26, No. 1, p 53-61, March 1975. 2 fig, 2 tab, 26 ref.

Descriptors: *Nitrate, *Cultivation, Soil, Soil investigations.

The concentration of nitrate-N at 30 cm depth in a clay soil was 2-5 times greater after ploughing than after direct drilling during the winter and spring of 1972-73. However, by early May no significant differences could be detected between cultivation treatments. It is concluded that decreased mineralisation of soil nitrogen in the direct-drilled soil is the main factor responsible for the differences observed.

75:020-098
GRAPHICAL REPRESENTATION OF TRICATIONIC EXCHANGES WHERE ONE OF THE CATIONS IS THE PROTON,
Andre, J.P.
Station d'Agronomie et de Physiologie Vegetale, 06600--Antibes, France.
Journal of Soil Science, Vol. 26, No. 1, p 81-92, March 1975. 5 fig, 16 equ, 1 ref.

Descriptors: *Model studies, Cation exchange, Soils, Soil investigations.

Most constituents of the adsorbing complex of the soil are cationic exchangers with variable exchange capacity; it is possible to study graphically exchanges involving the protons and two other cations. The representation developed here uses and generalizes the principle of the bicationic exchange isotherms in a square diagram. This helps to explain some experimental phenomena and enables the final equilibria of the exchange reactions to be forecast. The model seems useful for application in agronomy and physiology.

75:020-099
INTERACTIONS BETWEEN ORGANIC COMPOUNDS, MINERALS, AND IONS IN VOLCANIC-ASH-DERIVED SOILS: II. EFFECTS OF ORGANIC COMPOUNDS ON THE ADSORPTION OF PHOSPHATE,
Appelt, H., Coleman, N.T., Pratt, P.F.
Soil Science Society of America Proceedings, Vol. 39, No. 4, p 628-630, July-August 1975. 5 tab, 16 ref.

Descriptors: *Organic compounds, *Ions, *Adsorption, *Phosphate, Soils, Soil investigations.

The effects of organic compounds on phosphate adsorption by volcanic-ash-derived soils were studied using benzoate, p-OH benzoate, salicylate, and phthalate, and by humic and fulvic acids extracted from a surface soil sample of a Typic Dystrandept. The adsorption of simple organic anions that are specifically adsorbed block to some extent the adsorption sites for nonspecifically adsorbed anions such as chloride and/or nitrate. But, organic anions did not compete for or block adsorption sites for phosphate anions, because of the much higher affinity of phosphate for the adsorption sites in these volcanic-ash-derived soils.

75:020-100
SPECIFIC ADSORPTION OF TRACE AMOUNTS OF CALCIUM AND STRONTIUM BY HYDROUS OXIDES OF IRON AND ALUMINUM,
Kinniburgh, D.G., Syers, J.K., Jackson, M.L.
Massey University, Palmerston North, N.Z.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 464-470, May-June 1975. 5 fig, 1 tab, 17 ref.

Descriptors: *Iron, *Aluminum, *Adsorption, Chemical analysis, Chemical properties, Chemical reactions.

Freshly prepared Fe and Al hydrous oxide gels and the amorphous product of heating gibbsite selectively adsorbed traces of Ca and Sr from solutions containing a large excess of NaNO3. The fraction of the added Ca (Sr) adsorbed depended principally on the suspension pH, the amount of solid present, and to a lesser extent on the NaNO3 concentration.

75:02G-101
ON THE DIFFERENTIAL EQUATION FOR THE EQUILIBRIUM MOISTURE PROFILE IN SWELLING SOIL,
Sposito, G.
California University, Riverside. Dept. of Soil Science and Agricultural Engineering.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1053-1056, November-December 1975. 20 ref.

Descriptors: *Soil moisture, *Thermodynamics, Equations, *Equilibrium, *Expansive soils, Overburden, Earth pressure, Atmospheric pressure, Profiles, Soil water, Soil properties, Bulk density, Void ratio, *Moisture content, Physicochemical properties.

Differential equations which describe the equilibrium vertical distribution of moisture in swelling soil have been derived previously using both thermodynamic and fluid-mechanical methods. A fundamental disagreement exists between these expressions which was resolved in this paper through a detailed thermodynamic analysis of the equilibrium state of water in a swelling soil. The correct differential equation for the moisture profile was found and the discrepancy between previous results was shown to have been caused either by introduction of extra-thermodynamic variables or by an incorrect handling of the effect of overburden pressure on the soil water.

75:02G-102
PREDICTING IONIC DISTRIBUTIONS IN LARGE SOIL COLUMNS,
Wierenga, P.J.; Shaffer, M.J.; Gomes, S.F.; O'Connor, G.A.
New Mexico State Univ., University Park.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1080-1084, November-December 1975. 8 fig, 1 tab, 13 ref.

Descriptors: Irrigation effects, *Ions, *Soil profiles, *Soil chemistry, *Analytical techniques, *Distribution patterns, *Model studies, Chemical analysis, Evaluation, Soil analysis, Soil chemical properties, Soil physical properties, Drainage effects, Infiltration, Lysimeters, Instrumentation, Irrigation, Irrigation practice, Computer models, Soil water movement, *Return flow.

The distribution of various cations and anions was measured with depth and time in a large lysimeter column periodically irrigated in saline water. Samples of the soil solution were removed with extraction cups placed at depths of 25, 50, 75, 100, 125, and 150 cm below the soil surface in the lysimeters. Observed ionic distributions were compared with calculated values obtained by combining transient water flow model with a chemical plate theory model. Good agreement was obtained in observing a predicted depth distribution profile for SO4(--), Cl(-), Na(+), and Ca(++). Soluble Mg(++) and HCO3(-) concentrations were overpredicted suggesting that further refinement of the chemical subroutine may be needed.

75:02G-103
SEASONAL VARIABILITY OF RAINWATER REDISTRIBUTION BY FIELD SOILS,
Reid, I.
Birkbeck Coll., London (England).
Journal of Hydrology, Vol. 24, No. 1/2, p 71-80, April 1975. 4 fig, 3 tab, 11 ref.

Descriptors: *Rainfall disposition, *Infiltration, *Soil moisture, Moisture content Antecedent moisture content, Field capacity, Hysteresis, Soil moisture meters, Permeability, Soil-water-plant relationships, Variability, Seasonal.

Seasonal differences in post-infiltration redistribution of rainwater were evaluated for highly porous pasture soils. Winter soil drainage is precipitation-dependent, while soil-moisture fluctuations are a function of the relationship between antecedent soil water-content and the seasonal mean and are largely independent of infiltration quantities. Summer soil drainage is dependent upon both rainfall and differential soil absorption and was described by a linear multiple regression model. The seasonal nature of redistribution is an important consideration of catchment water disposition, and is useful as a control in the evaluation of optimal irrigation practice under field conditions. Temporal changes in soil-moisture response to rainfall exposed difficulties in the conceptualization of field capacity and soil-moisture deficit.

75:020-104
MEASUREMENT OF HYDRAULIC CONDUCTIVITY AND DIFFUSIVITY FOR PREDICTING THE PROCESS OF SOIL WATER INFILTRATION FROM A TRICKLE SOURCE,
Ben-Asher, J., Diner, M., Brandt, A., Goldberg, D.
University of the Negev, Beersheba (Israel). Research and Development Authority.
Water Resources Bulletin, Vol. 11, No. 6, p 1187-1196, December 1975. 5 fig, 8 ref.

Descriptors: *Soil water movement, *Infiltration, *Laboratory tests, *Diffusivity, *Hydraulic conductivity, Unsteady flow, Mathematics, Equations, Moisture content, Unsaturated flow, Soil moisture, Percolation, Permeability, Retention, Field capacity.

Two soil water functions, hydraulic conductivity K and diffusivity D, were estimated by two methods. In one method D was estimated according to Bruce and Klute (1956), and K was calculated from D and the retention curve. In the second, K was obtained by field estimation, with D being calculated from K and the retention curve. The criterion of reliability for both methods was agreement between experimental and predicted distribution of soil water content. The prediction was made using the functions K and D as soil water parameters in both methods. Theoretical and experimental agreement was generally good. The first method, however, was found to be best for high soil water content and the second for low soil water content. In addition, the water content at the end of the monotonic increase of function D (estimated according to Bruce and Klute, 1956) was found to be about the upper limit of field soil water content. It can be used as a boundary condition in the numerical solution of a cylindrical model of infiltration from a trickle source. It was concluded that the best agreement between theory and experiment can be found when the combined values of D and K from both methods of estimation are used.

75:020-105
SULFUR FRACTIONS AND CARBON-NITROGEN-PHOSPHORUS-SULFUR RELATIONSHIPS IN SOME BRASILIAN AND IOWA SOILS,
Neptune, A.M.L., Tabatabai, M.A., Hanway, J.J.
Iowa State University, Ames 50010
Soil Science Society of America Proceedings, Vol. 39, No. 1, p 51-55 January-February 1975. 5 tab, 28 ref.

Descriptors: *Sulfur, Soils, Soil properties, Soil tests, Iowa, Carbon, Nitrogen, Phosphorus.

Current knowledge concerning the percentage distribution of the various S fractions in soils is mainly derived from studies of S in surface soils of temperate regions. This study was conducted to determine the S fractions and C-N-P-S relationships in some subtropical soils from Brasil and to compare the values in these soils with those in soils of a temperate region from Iowa.

75:020-106
FERTILIZER OR SALT LEACHING AS AFFECTED BY SURFACE SHAPING AND PLACEMENT OF FERTILIZER AND IRRIGATION WATER,
Kemper, W.D., Olsen, J., Hodgdon, A.
Colorado State University, Fort Collins, CO 80521
Soil Science Society of America Proceedings, Vol. 39, No. 1, p 115-119, January-February, 1975. 4 fig, 9 ref.

Descriptors: *Irrigation, *Furrow irrigation, *Surface irrigation, Fertilization, Leaching, Root zone, Irrigation effects, Return flow.

Irrigation in furrows and placement of fertiliser in bands in ridges was evaluated as a means for allowing overirrigation to bypass nitrate and reduce leaching losses. In a loamy sand, placement of band 0 to 5 cm higher than the surface of water in the furrow allowed over 120 cm of overirrigation before the salt began to leave the root zone. In the clay loam a similar delay of nitrate removal was not achieved until the band was 10 cm higher than the water surface. This difference appeared to be associated with a perched water table that developed in the "cultivated" layer of the clay loam soil due to higher hydraulic conductivity in cultivated than in the lower soil. Downward movement of relatively concentrated salt solution near the band, due to its greater density, was a factor that allowed fertiliser bands at lower levels to enter the mainstream of the leaching water.

75:020-107
A HYDRAULICALLY DRIVEN SOIL AUGER FOR SAMPLING FINE-TEXTURED AND WET SOILS.
Byrnes, B.H.
Remote Sensing Institute, South Dakota State University, Brookings, 57006.
Soil Science Society of America Proceedings, Vol. 39, No. 1, p 156, January-February 1975. 1 Fig, 1 ref.

Descriptors: Soil tests, Soil investigations, Soils, Equipment.

A core-type bucket auger was modified to fit the drive bar of a hydraulic soil probe with a rotor head. This auger satisfactorily samples claypan, fine-textured and moderately fine-textured soils in a wet condition. The auger system can readily be used alternately with tube core samplers.

75:020-108
A TECHNIQUE FOR INSTALLING INDUCTION COILS IN A PROFILE WITH MINIMUM SOIL DISTURBANCE.
Spotts, J.W., Brown, K.W.
Environmental Effects Laboratory, United States Army Engineer Waterways Experiment Station, Vicksburg, MS 39180.
Soil Science Society of America Proceedings, Vol. 39, No. 5, p 1006-1007, September-October 1975. 4 Fig.

Descriptors: *Soil mechanics, Soil investigations, Soil tests, Soil properties, Soil engineering.

Details of a technique are given which can be used to position induction coils in an undisturbed soil profile to study the shrinking and swelling within the soil profile with changing moisture content. The specially designed apparatus consists of a soil cutting blade which can be advanced horizontally from an access hole into the soil at the desired depth. The induction coils are installed in the slots after the holes have been cut. Installations have been made successfully at depths as great as 2 m.

75:020-109
A COMPACTION APPARATUS FOR THE PREPARATION OF SOIL CORES OF DIFFERENT BULK DENSITIES AND THICKNESSES.
Baligar, V.C., Nash, V.E., Shuman, F.L., Jr.
Soil Science Society of America Proceedings, Vol. 39, No. 5, p 1002-1003, September-October 1975. 2 Fig, 1 tab, 7 ref.

Descriptors: *Bulk density, *Moisture tension, Root development, Soil tests, Soil investigations, Laboratory equipment, Laboratory tests.

The apparatus reported herein enables one to prepare soil cores with a desirable bulk density and having different thicknesses for use in soil compaction and plant growth studies.

75:020-110
SIMULATION OF ROOT-ZONE WATER AND DEEP SEEPAGE TO A WATER TABLE.
King, T.G., Lambert, J.R.

Connell/Metcalf & Eddy, Coral Gables, Florida.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, December 15-18, 1975. Chicago, Illinois. 12 p, 5 fig, 3 ref.

Descriptors: *Model studies, *Root zone, Moisture tension, Soil water, Soil water movement, Seepage, Water table, Evapotranspiration.

The primary objective of this investigation was to develop a computer model that would simulate the quantity and movement of water in the deep seepage region, i.e., between the root zone and the water table. Effort was also directed towards simulating evapotranspiration and the movement of the water table. The model has been structured so that it may readily be modified to other locations where basic meteorological records and soil data are available.

75:02G-111
EFFECTS OF PHOSPHORUS ON SOME PHYSICAL AND CHEMICAL PROPERTIES OF CLAYS,
Lutz, J.F., Haque, I.
Lyallpur University, Lyallpur, West Pakistan.
Soil Science Society of America Proceedings, Vol. 39, No. 1, p 33-36, January-February 1975. 3 fig, 5 tab, 17 ref.

Descriptors: *Clays, *Phosphorus, Soils, Soil investigations, Soil chemistry.

Montmorillonite, kaolinite, and a 1:1 mixture of them were treated with phosphorus at rates as high as 1,600 ppm using phosphoric acid and monocalcium phosphate. After 3 months the clays were examined for pH, zeta potential (charge), swelling, hydration in suspension, modulus of rupture of briquets, and water retention at 5 and 15 bars pressure.

75:02G-112
SUPERSATURATION PHENOMENA AND THE FORMATION OF FLUORAPATITE IN AQUEOUS SUSPENSIONS OF PHOSPHATE ROCK,
Chien, S.H., Wier, D.R., Black, C.A.
Washington University, St. Louis, Missouri
Soil Science Society of America Proceedings, Vol. 39, No. 1, p 43-47, January-February 1975. 1 fig, 4 tab, 14 ref.

Descriptors: *Acids, *Rocks, Rock properties, Soil investigations.

Dilute HCl solutions equilibrated with Florida phosphate rock and Tennessee brown phosphate rock in the presence of solid fluorite developed a condition of supersaturation with respect to fluorapatite at 25C. In suspensions boiled before equilibration at 25C, however, the solutions were in equilibrium with fluorapatite, as evidenced by ion-activity products for fluorapatite in the solutions.

75:02G-113
BONDING OF CALCIUM AND POTASSIUM BY VERMICULITE AND KAOLINITE CLAYS AS AFFECTED BY H-CLAY ADDITION,
Hawaja, A.H., McLean, E.O.
Ohio State University, Columbus, OH 43210
Soil Science Society of America Proceedings, Vol. 39, No. 1, p 48-50, January-February 1975. 2 fig, 1 tab, 16 ref.

Descriptors: *Kaolinite, *Calcium, *Potassium, Soils, Soil investigations.

The less than 2 micron fraction of Libby vermiculite and Peerless kaolinite was separated and H-saturated by resin treatment. The H-clay suspensions were immediately saturated with either Ca or K by addition of the respective hydroxides. Six reciprocal Ca-K saturations of each clay were prepared by mixing the Ca-and K-clays in appropriate amounts. Increments of H-clay were added to lower the base saturation and thereby inactivate the pH-dependent charges.

75:02G-114
YIELD RESPONSE OF ALFALFA CULTIVARS AND CLONES TO SEVERAL pH LEVELS IN TATUM SUBSOIL,
Buss, G.R., Lutz, J.A. Jr., Hawkins, G.W.
Virginia Polytechnic Institute and State University, Blacksburg, VA. Agronomy Department.
Agronomy Journal, Vol. 67, No. 3, p 331-334, May-June 1975. 5 tab, 8 ref.

Descriptors: *Aluminum, *Alfalfa, Crop response, Subsoil, Soil investigations, Soil tests.

Breeding for increased tolerance to high aluminum-low pH soils should enlarge the range of adaptation of alfalfa. This research was undertaken to obtain information on the range of genetic variation present in alfalfa cultivars for reaction to soil pH in a high aluminum soil. Eighteen alfalfa cultivars were planted in unlimed (pH 4.6) and limed (pH 6.0) Tatum subsoil. None survived in the unlimed soil and all grew in the limed soil. Clones were selected for root development in unlimed soil after growing down through a 5 cm layer of limed soil. When grown at pH levels of 5.3, 6.1, and 7.5, they showed a highly significant clone X pH interaction for yield. However, on the average they did not seem much more acid tolerant than unselected clones. This screening technique was somewhat successful in isolating acid tolerant clones, but forage yield at low pH appeared to be a better criterion. Our results indicate that alfalfa cultivars exhibit a narrower range of acid tolerance than is known to exist in several other crop species, but that individual clones differ in their reaction to both low and high soil pH.

75:02G-115
INTERACTIONS OF MICRONUTRIENTS IN BARLEY GROWN ON ZINC-POLLUTED SOILS,
Singh, B.R., Steenberg, K.
H.P. University, Palampur, 176061 H.P. India.
Soil Science Society of America Proceedings, Vol. 39, No. 4, p 674-679, July-August 1975. 2 fig, 7 tab, 41 ref.

Descriptors: *Nutrients, *Barley, *Zinc, Soil tests, Soil investigations, Crop response, Pollution.

Barley grown in zinc-polluted soils with variable levels of Zn, Mn, and Fe showed no marked differences in the yield attributable to these variables in both soils investigated. However, in direct contrast to results reported by other investigators, concentrations of 65Zn and total zinc were found to increase with increased levels of added Mn and/or Fe with few exceptions. Similarly, concentrations of 54Mn and total Mn also increased with increased levels of Zn and/or Fe. The effects of Zn and Mn on the concentrations of 59Fe and total Fe were inconsistent. The concentration of Mo was found to decrease with increased levels of Zn, Mn, and Fe and the decrease was more pronounced in one soil than in the other.

75:02G-116
EFFECT OF DEGREE OF SOIL PROFILE DISRUPTION ON PLANT GROWTH AND SOIL WATER EXTRACTION,
Rabov, R., Eck, H.V.
N Poushkarov Institute of Soil Science, Sofia, Bulgaria.
Soil Science Society of America Proceedings, Vol. 39, No. 4, p 744-746, July-August 1975. 1 fig, 3 tab, 9 ref.

Descriptors: *Soil profiles, *Infiltration, Soil investigations, Soil environment, Soil water, Soil horizons.

Modification of slowly permeable soil profiles has been effective in ameliorating undesirable soil conditions. Various methods and depths of modification have been studied but little attention has been given to (i) the degree of disruption necessary to accomplish satisfactory profile modification or (ii) the relative merits of topsoil-subsoil mixing and stockpiling and returning topsoil to the surface after profile modification. We studied seven degrees of profile disruption (clod size distributions in the B22t and mixing of topsoil with that horizon) in simulated soil profiles in the greenhouse. Grain sorghum was grown on Pullman clay loam. Disturbance of the B22t layer increased yields but once that layer was disturbed, degree of disturbance had no further effect on yield. Compared with retaining topsoil on the surface, mixing it with the B22t did not affect yields.

75:02G-117
SOIL CHANGES RESULTING FROM CROPPING,
Skidmore, E.L., Carstenson, W.A., Banbury, E.E.
United States Department of Agriculture, Agricultural Research Service, Manhattan, Kansas.
Soil Science Society of America Proceedings. Vol. 39, No. 5, p 964-967, September-October 1975. 3 fig, 2 tab, 24 ref.

Descriptors: *Crops, Crop production, Soil investigations, Soil properties, Grasses, Pastures, Soil structure, Organic matter.

The need to document further the changes in soil properties from various cropping systems and the uniqueness of a long-time cultivated field adjacent to buffalograss pasture prompted us to evaluate soil-property changes of a Keith silt loam characteristic of that pasture and field. In the fall of 1971, we broke the sod of the buffalograss pasture for analysis. Soil samples were obtained from the pasture (newly broken sod) and the adjacent cultivated field. The wet aggregates from the pasture were stabler as compared with the cultivated field for both flash and vacuum wetting. However, the dry aggregates from the cultivated field were slightly stabler than those from the pasture.

75:02G-118
A THERMODYNAMIC MODEL FOR PREDICTING THE FORMATION, STABILITY, AND WEATHERING OF COMMON SOIL MINERALS,
Rai, D., Lindsay, W.L.
Battelle Northwest, Box 999, Richland, Washington 99352.
Soil Science Society of America Proceedings, Vol. 39, No. 5, p 991-996, September-October 1975. 5 fig, 2 tab, 6 equ, 33 ref.

Descriptors: *Model studies, *Weathering, Soils, Soil investigations.

Numerous workers have examined the weathering products of soil minerals and have proposed empirical weathering sequences. The present paper outlines the development of a thermodynamic model that predicts in a systematic way several mineral transformations that can occur in soils. According to this model, the stability of primary minerals increases in the order: Na-glass, K-glass, pyroxene, analcime, anorthite, low albite, muscovite, microcline, and quartz. The stability of secondary clay minerals depends on soluble silica. At pH 6 with high silica the order of increasing stability is: chlorite, halloysite, gibbsite, illite, dickite, beidellite, kaolinite, and montmorillonite; at low silica the order is: chlorite, halloysite, illite, beidellite, montmorillonite, dickite, kaolinite, and gibbsite. The stability of both primary and secondary minerals increases with pH.

75:02G-119
TRANSPORT OF WATER AND HEAT IN A FROZEN PERMEAMETER,
Miller, R.D., Loch, J.P.G., Bresler, E.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1029-1036, November-December 1975. 6 fig, 1 tab, 40 equ, 16 ref.

Descriptors: *Frozen ground, *Frozen soils, Soil water, Soil water movement, Model studies, Permeameters, Soil properties.

Transport of water in frozen soils is probably not restricted to fluid phases. In a frozen permeameter a series-parallel mode of transport should exist in which the ice phase may move with uniform translational velocity in a stationary pore system formed by particles having adsorbed films of unfrozen water. A microscopic model for coupled mass and heat transport would be complex, but foundations for such a model are laid in an exercise which derives direct and cross coefficients for coupled transport equations applicable to a permeameter containing a simplified (nontortuous) "soil" with uniform cylindrical channels, ice-filled except for films adsorbed at channel walls. Temperature dependence of coefficients, assuming Newtonian shear in the film, can be modeled using standard double-layer theory.

75:02G-120
CHANGES IN THE PHYSICAL PROPERTIES OF SOIL CLAYS DUE TO PRECIPITATED ALUMINUM AND IRON HYDROXIDES: I. SWELLING AND AGGREGATE STABILITY AFTER DRYING,
El-Swaify, S.A., Emerson, W.W.
Department of Agronomy and Soil Science, University of Hawaii, Honolulu 96822.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1056-1063, November-December 1975. 5 fig, 6 tab, 25 ref.

Descriptors: Soils, Soil properties, Soil investigations, Aluminum, Iron, Soil chemistry, Soil chemical properties.

Compressed discs of an illite, a kaolinite, and a mixture of the two were formed from freeze-dried dispersed suspensions of the clays, into which one level of Fe(OH)3 and two levels of Al(OH)3 had been precipitated. The precipitated Fe was found to consist of particles about 60A in diameter and amorphous to x-ray, rather than the acicular goethite that precipitates under similar conditions in the absence of clay. It was deduced from N2 and water vapor sorption measurements that the precipitated Al was present as very thin layers on the surface of the clay particles, which in the case of the illite could bridge some of the particles. Their form was generally indeterminate, in contrast to the well-crystallized bayerite formed in the absence of clay.

75:02G-121
THE USE OF A SPECIFIC ION ELECTRODE FOR DETERMINATION OF BROMIDE IN SOILS,
Onken, A.B., Hargrove, R.S., Wendt, C.W., Wilke, O.C.
Texas Agricultural Experiment Station, Texas A&M University, Agricultural Research and Extension Center, Lubbock, Texas.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1223-1225, November-December 1975. 3 tab, 2 equ, 9 ref.

Descriptors: *Bromides, *Electrodes, *Tracers, Soil tests, Soil investigations, Chloride, Anions.

Bromide has desirable characteristics for use as a tracer for NO3- in some soil studies. However, its quantitative determination in the presence of Cl-, which occurs in interfering quantities in many soils, requires lengthy procedures. Further, Br- interferes with the quantitative determination of Cl- for which concentrations may also need to be determined. To facilitate the use of Br- as a tracer in such tests, a procedure for the rapid and accurate determination of water-extractable Br- in the presence of Cl- and Cl- in the presence of Br- was developed. These quantitative determinations over a wide range of concentrations were accomplished by use of standard curves, interference curves, and successive approximations. Bromide added to soil over a wide range of concentrations was quantitatively recovered.

75:02G-122
A MODEL FOR THE SIMULTANEOUS PRODUCTION AND DIFFUSION OF FERROUS IRON IN SUBMERGED SOILS,
Harmsen, K., Van Breemen, N.
Department of Soils and Fertilizers, Agricultural University, P.O. Box 37, Wageningen, The Netherlands.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1063-1068, November-December 1975. 8 fig, 14 equ, 19 ref.

Descriptors: *Model studies, *Iron, *Saturated soils, Soil horizons, Soils, Soil investigations, Rice.

The model describes the distribution of dissolved ferrous iron as a function of time and depth in a flooded soil profile consisting of three distinct horizons. In this soil profile, the production of dissolved ferrous iron is high and constant with depth in the surface horizon, low and constant with depth in the subsoil, and varies linearly with depth between these two values in the intermediate horizon. The Fe^{2+} concentration is found as the difference of the rate of ferrous iron production, integrated over time and a diffusion term consisting of an infinite series of the third and fifth repeated integral of the complementary error function. The parameters considered are (i) three constants specifying the dependence of the ferrous iron formation on time and depth, (ii) the depths of the three horizons, and (iii) the apparent diffusion coefficient. As shown by one example, the general solution can be greatly simplified for many cases of practical interest. The inherent assumptions of the model and its application to actual water-logged soils are discussed.

75:02G-123
SOIL POTASSIUM RELATIONSHIPS AS INDICATED BY SOLUTION EQUILIBRATIONS AND PLANT UPTAKE,
Munn, D.A., McLean, E.O.
Department of Agronomy, Ohio State University.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1072-1076,
November-December 1975. 2 Fig, 7 tab, 17 ref.

Descriptors: *Potassium, *Corn, *Ohio, Soils, Soil investigations, Soil chemistry, Nutrients, Fertilizer, Fertilization.

Four Ohio soils of wide range in K release capability were initially K-treated and successively cropped three times with corn in a growth chamber. Aliquots of the soils with and without K added and before and after cropping were assayed by extraction, equilibration, and plant uptake techniques for the effects of cropping and K-treatment. Uptake of K by the corn was closely related to the K release capabilities of the soils. Exchangeable K increased as rate of K increased. Initial cropping decreased the exchangeable K in all soils eliminating the effect of K treatments on exchangeable K. However, after initial cropping where no K was added, exchangeable K varied sixfold from the lowest to the highest.

75:02G-124
NITRATE-NITROGEN REMOVAL FROM SOIL PROFILES BY ALFALFA,
Mathers, A.C., Stewart, B.A., Blair, B.
USDA, and Texas A&M University, Soil, WAter and Air Sciences, Southern Region, Agricultural Research Service.
Journal of Environmental Quality, Vol. 4, No. 3, 1975. p 403-405, 3 fig, 3 tab, 12 ref.

Descriptors: *Nitrate, *Nitrogen, *Alfalfa, Crop response, Crop production, Phosphorus, Soil investigations, Soil profiles.

Alfalfa was established in the fall of 1971 on plots previously treated with 0, 22, 45, 112, or 224 metric tons/ha of manure annually for 3 years. Additional plots had received 224 kg N/ha annually for 3 years. Nitrate-nitrogen and water contents of the soil profile were determined by 30-cm increments to 6 m prior to planting. Nitrate-nitrogen was found to 6 m, but the largest concentrations were in the top 1.8 m, where amounts of $NO_3(-)$-N varied from 100 to 2,400 kg/ha. Additional profile samples were taken in 1972 and 1973 after the final cutting of alfalfa. The data showed that alfalfa removed water and $NO_3(-)$-N to a 1.8-m depth the first year and to 3.6 m the second year. These results indicate that alfalfa could remove $NO_3(-)$-N from the lower depth of soil profiles where annual crops were not effective. Yield, $NO_3(-)$-N, and P contents of alfalfa were increased by manure. Total N taken up by the crop was directly related to the yield.

75:02G-125
A DEVICE FOR ISOLATING FIELD SOIL COLUMNS WITH MINIMUM DISTURBANCE,
Brown, K.W.
Soil and Crop Sciences Department, College Station, Texas 77843.
Soil Science Society of America Proceedings, Vol. 39, No. 5, p 1008-1009,

November-December 1975. 3 fig, 2 ref.

Descriptors: Soil investigations, Lysimeters, Soil tests.

A device is described which can be used to dig a ditch to isolate soil blocks in the field. The ditch can be as deep as 1.5 m with a width of 2.5 cm thus minimizing the amount of soil disturbance in individual blocks. The necessary equipment can be fabricated in a well equipped shop with a minimum of expense.

75:020-126
DENITRIFICATION IN SUBSOILS OF THE NORTH CAROLINA COASTAL PLAIN AS AFFECTED BY SOIL DRAINAGE,
Gambrell, R.P., Gilliam, J.W., Weed, S.B.
North Carolina Agricultural Experiment Station, Raleigh, NC
Journal of Environmental Quality, Vol. 4, No. 3, 1975, p 311-316, 5 fig, 1 tab, 15 ref.

Descriptors: *Denitrification, Nitrogen, Nitrogen cycle, Subsoil, North Carolina, Drainage, Drainage effects, Soil investigations.

In a tiled moderately well-drained soil, over 200 kg NO3-N/ha were generally found distributed throughout the top 3 m. However, in a poorly drained soil, relatively low levels of NO3 were found in the top m and very little NO3 persisted in the saturated zone beneath 1 m. Oxidation-reduction potential (Eh) measurements in the tiled moderately well-drained soil indicated well-oxidized conditions to 3 m. The Eh measurements beneath 1 m in the poorly drained soil consistently indicated favorable conditions for denitrification. A marked decrease in the NO3-N/Cl ratio with depth in the poorly drained soil consistently indicated favorable conditions for denitrification. A marked decrease in the NO3-N/Cl ratio with depth in the poorly drained soil supported the contention that denitrification was occurring in the soil.

Section VIII

WATER CYCLE

LAKES (GROUP 02H)

75:02H-001
GEOCHEMISTRY AND NATURAL IONIC AND ISOTOPIC TRACING: TWO COMPLEMENTARY WAYS TO STUDY THE NATURAL SALINITY REGIME OF THE HYDROLOGICAL SYSTEM OF LAKE CHAD,
Roche, M-A.
Office de la Recherche Scientifique et Technique Outre-Mer, Paris (France). Hydrology Section.
Journal of Hydrology, Vol. 26, No. 1/2, p 151-171, July 1975. 7 fig, 1 tab, 28 ref.

Descriptors: *Lake basins, *Hydrologic systems, *Water chemistry, *Isotope studies, *Saline lakes, Groundwater, Geochemistry, Lakes, Lake sediments, Salinity, Ions, Chemical analysis, Cations, Chromatography.

As a consequence of intense evaporation and transit through a succession of sedimentary traps (flood plains, lake, dune aquifer, and interdune depression), the isotopic composition and the characteristics of the dissolved and suspended loads of Lake Chad water change downstream in a regular manner resembling chromatography. The migration of the water and chemical constituents from one end to the other of this endorheic basin, extending from the humid tropics to the desert margins, was outlined and quantified. The erosion, transport, and sedimentation phenomena and the natural saline and isotope tracing methods were studied simultaneously. It was illustrated that these two avenues of research are complementary, justifying the use of common models, and are indispensable to each other.

75:02H-002
EFFECTS OF WATERHYACINTH COVER ON WATER CHEMISTRY, PHYTOPLANKTON, AND FISH IN PONDS,
McVea, C., Boyd, C.E.
Southern Region, Agricultural Research Service, United States Department of Agriculture and the Louisiana Agriculture Experiment Station, Baton Rouge.
Journal of Environmental Quality, Vol. 4, No. 3, 1975. p 375-402, 5 tab, 27 ref.

Descriptors: *Water hyacinth, *Aquatic life, *Water chemistry, *Aquatic weeds, Water quality, Fish, Ponds, Pondweeds, Phosphorus.

Water hyacinth cover of 0, 5, 10, or 25% surface was established in fertilized ponds stocked with the fish, Tilapia aurea, at Auburn, Alabama. Measurements of water chemistry, phytoplankton density, and fish production were made during the 1971 growing season. Phytoplankton production was less in ponds with 10 and 25% cover by waterhyacinth than in ponds with 0 and 5% cover. Competition of waterhyacinth with phytoplankton involved shading and removal of phosphorus from the water. Concentrations of dissolved oxygen were lowest in ponds with 25% cover, but oxygen tensions in all ponds were adequate for survival and growth of fish. Reduction in phytoplankton growth in ponds with 10 and 25% cover resulted in much lower fish production. The presence of 5% cover by waterhyacinth did not significantly affect fish production.

Section IX

WATER CYCLE

WATER IN PLANTS (GROUP 02I)

75:02I-001
SALT TOLERANCE AND SUITABILITY OF VARIOUS GRASSES FOR SALINE ROADSIDES,
Hughes, T.D., Butler, J.D., Sanks, G.D.
Turfgrass extention, Colorado State University, Fort Collins, Colorado 80523
Journal of Environmental Quality, Vol. 4, No. 1, p 65-68, January-March 1975.
1 fig, 6 tab, 12 ref.

Descriptors: *Salinity, *Crop response, *Saline soils, *Grasses, *Salt tolerance.

Forage yields of five species were studies in soil under greenhouse conditions with NaCl additions of 0; 5,000; 10,000; and 20,000 ppm. Forage yield of P. distans was reduced 21% by addition of 20,000 ppm NaCl, compared to a minimum reduction of 40% for the other grass species. Mineral analysis of leaf tissue by emission spectroscopy showed that Na concentrations increased as NaCl addition to the soil increased. However, there was no relationship between salt tolerance of the various grasses and amounts of Na in leaf tissue. Increased NaCl addition to the soil resulted in decreased leaf Ca and Mg, but no relationship existed between leaf K and NaCl addition.

75:02I-002
LEAF PHOTOSYNTHESIS: THE INFLUENCE OF ENVIRONMENTAL VARIABLES,
Incropera, F.P.
California University, Berkeley, Department of Mechanical Engineering.
Journal of Environmental Quality, Vol. 4 No. 4, p 440-447, October-December 1975.
13 fig, 35 ref, 1 append.

Descriptors: *Crop response, *Model studies, *Corn, *Photosynthesis, Environmental effects, Environmental control, Environment.

A model is presented for the effects of light intensity and ambient temperature, relative humidity, and carbon dioxide concentration on leaf photosynthesis. The model treats diffusion and chemical processes occurring within the leaf, as well as the transfer of mass and energy between the leaf and its environment. Calculations have been performed for Zea mays L. (maize) which suggest the influence of environmental changes. Although leaf energy exchange processes act to moderate the effect of changes in the atmospheric temperature, a severe cooling trend may cause as much as 25% reduction in photosynthesis. Under most conditions, the rate of photosynthesis is further diminished by a reduction in relative humidity. In contrast, a 20% increase in the atmospheric CO2 concentration, which is projected for the year 2000, will increase photosynthesis by approximately 15%. The calculations also suggest optimum ambient conditions for controlled growth environments, such as a greenhouse.

75:02I-003
LEAF WATER POTENTIAL AND MOISTURE BALANCE--FIELD DATA,
Huck, M.G., Browning, V.D., Young, R.U.
Agricultural Engineering Department, Agricultural Experiment Station, Auburn, Alabama.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, 15 pages, December 15-18, 1975, Chicago, Illinois. 6 fig, 2 tab, 11 ref.

Descriptors: *Root development, *Root distribution, *Root system, Soil moisture, Soil water, Soil-water-plant relationships, Irrigation, Irrigation practices, Transpiration.
(See 75:03F-066 for article)

75:02I-004
PLANT WATER STRESS CRITERIA FOR IRRIGATION SCHEDULING,

Stegman, E.C., Schiele, L.H., Bauer, A.
Agricultural Engineering Department, North Dakota State University, Fargo, North Dakota.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, December 15-18, 1975, Chicago, Illinois. 7 fig, 6 tab, 18 ref.

Descriptors: *Soil water, *Soil moisture, *Soil-water-plant relationships, Scheduling, Crop response, Plant Physiology, Plant tissues, Stress, Stress analysis, Irrigation, Irrigation effect.
(See 75:020-067 for article)

75:021-005
DISTRIBUTION OF SALTS IN THE ROOT ZONE,
Raats, P.A.C.
Agricultural Research Service, Riverside, California Salinity Lab.
Journal of Hydrology, Vol. 27, No. 3/4, p 237-248, December 1975. 7 fig, 21 ref.

Descriptors: *Salts, *Root zone, *Distribution, Absorption, Soil water, Soil profiles, Depth, Salinity, Leaching, Salt balance, Saline water, Convection, Irrigation, Evaporation, Transpiration, Drainage, Velocity, Travel time, Tensiometers.

Selective uptake of water and convection of salts with the soil water are the main factors governing the distribution of salts in the soil profile. Depth-time trajectories of elements of water were calculated as a function of their initial position, the average soil water content, the uptake distribution, and the rates of irrigation, evaporation, transpiration, and drainage. The mass balance for the salt was reduced to a linear, first-order partial differential equation whose characteristics are the depth-time trajectories of elements of water. Expressions for the increase in salinity along the trajectories were derived. In all specific calculations, it was assumed that the rate of uptake has its maximum at the soil surface and decreases exponentially with depth. As illustrations, calculations were made of depth-time trajectories of elements of water, steady and transient salinity profiles, and the responses of salinity sensors at various depths following a step increase and a step decrease of the leaching fraction.

75:021-006
CROP STATUS EVALUATIONS AND YIELD PREDICTIONS,
Haun, J.R.
Department of Horticulture, Clemson University, Clemson, S.C.
Annual Summary Report, March 1975. 41 p, 16 fig, 8 tab, 1 append.

Descriptors: *Crop response, *Yield equations, Model studies, Mathematical models, Wheat.

The work reported herein was based on the program outlined in the reference NASA Headquarter's Y-001-041. During the course of this work it was decided to extend the contract to include the remaining portion of the 1974-75 winter wheat season and to collect data on a second season of both spring and winter wheat.

75:021-007
PRECIPITATION OF CALCIUM AND STRONTIUM SULFATES AROUND PLANT ROOTS AND ITS EVALUATION,
Malzer, G.L., Barber, S.A.
Minnesota University, Minneapolis, 55455.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 492-495, May-June 1975. 2 fig, 2 tab, 8 ref.

Descriptors: *Precipitation, *Calcium, *Strontium, *Sulfates, Root system.

The flux of Ca2+, and SO4(2-) to corn roots was investigated to determine if accumulation at the root caused precipitates to form and if so to determine the influence of precipitate formation on Ca and Sr uptake. Autoradiographic techniques using 45Ca and 35S showed both Ca2+ and SO4(2-) accumulated at root surfaces when supply by mass-flow exceeded uptake. Petrographic studies of the roots confirmed the formation of CaSO4 precipitates.

75:021-008
DIURNAL FLUCTUATION OF LEAF-WATER POTENTIAL OF CORN AS INFLUENCED BY SOIL MATRIC POTENTIAL AND MICROCLIMATE,
Reicosky, D.C., Campbell, R.B., Doty, C.W.
ARS-USDA, Florence, SC 29501.
Agronomy Journal Vol. 67, No. 3, p 380-385, May-June 1975. 4 fig, 1 tab, 21 ref.

Descriptors: *Microclimatology, *Moisture stress, *Moisture tension, Crop response, Corn, Irrigation, Irrigation effects, Crop production.

Water stress during critical growth periods is frequently the limiting factor in crop production. However few data are available on the variation of plant water status under field conditions. The object of this work was to quantify the effect of soil matric potential on plant water status. Sweet corn was grown on a Varina sandy loam soil to determine the effect of the microclimate and irrigation on leaf water potential. Soil water stress was imposed naturally and by use of automated portable shelters that covered the plots during rainfall. Leaf-water potential was closely related to the diurnal change of incoming energy. A maximum leaf-water potential of -1.5 bars occurred just prior to sunrise. The minimum value, which occurred during the peak radiation load or stress, was dependent on soil matric potential and stage of plant development.

75:021-009
CALCULATION OF RATE OF NUTRIENT UPTAKE BY GROWING ROOTS,
Khasawneh, F.E.
Agronomy Journal, Vol. 67, No. 4, p 574-576, July-August 1975. 21 equ, 7 ref.

Descriptors: *Root development, *Root systems, *Nutrients, *Nutrient removal, *Fertilizers, Mathematical analysis, Crop response.

Equations are presently available to calculate the rate of nutrient uptake by growing roots. They can be used to estimate an average rate of uptake by the entire root system, but they fail to give specific information on uptake by a unit segment of root or on the effects of aging and morphological changes of such a segment on its capacity for uptake. This paper gives a theoretical analysis of the process of nutrient uptake by a growing root system. The objective of this analysis is to derive equations that would give such specific information. A frequency distribution function is used to partition root systems into a continuum of age groups, each possessing a rate of uptake that is a function of the age of that group. Equations are derived that utilize time-series measurements of root length and nutrient accumulation in the plant. These derivations are used to calculate parameters of nutrient uptake related to two properties of the root system: (i) the rate of nutrient uptake of a unit segment of root and the manner by which this rate changes with aging and (ii) the rate of nutrient flux into the entire root system as a function of time.

75:021-010
RESPONSES OF BERMUDAGRASS TO SALINITY,
Ackerson, R.C., Youngner, V.B.
California University, Riverside, CA 92502
Agronomy Journal, Vol. 67, No. 5, p 678-681, September-October 1975. 6 tab, 27 ref.

Descriptors: *Bermudagrass, *Crop response, *Salinity, Turf grasses, Turf, Salt tolerance.

Bermudagrasses are salt-tolerant grasses valuable for forage and turf. Experiments were conducted to determine specific responses to increasing salinity to provide a basis for breeding of more salt tolerant, agronomically desirable strains.

The cultivar "Santa Ana" was grown in solution cultures containing increasing levels of $NaCl$ and $CaCl_2$ or K_2SO_4. Dry weight of tops decreased while dry weight of roots and total nonstructural carbohydrate concentrations of crowns, but not roots, increased with increased salinity of the culture solution.

75:021-011
RESISTANCE TO WATER TRANSPORT IN RICE PLANTS,
Tomar, V.S., Ghildyal, B.P.
University of Agriculture & Technology, Pantnagar, Nainital, India.
Agronomy Journal, Vol. 67, No. 2, p 269-272, March-April 1975. 3 fig, 1 tab, 12 ref.

Descriptors: *Rice, *Transpiration, Soil-water-plant relationships, Irrigation, Irrigation practices.

Rice is grown either in continuously flooded "lowland" soils or under rainfed conditions in "upland" soils. The objective of the study was to determine whether there are differences in resistance to water transport between plants grown in flooded and nonflooded soils. This information may be useful in understanding the plant-water relations under two cultural practices.

75:021-012
ESTIMATING RELATIVE LEAF WATER CONTENT WITH A SIMPLE BETA GAUGE CALIBRATION,
Obrigewitch, R.P., Rolston, D.E., Nielsen, D.R., Nakayama, F.S.
Soil Conservation Service, Klamath Falls, Oregon.
Agronomy Journal, Vol. 67, No. 5, p 729-732, September-October 1975. 3 fig, 8 ref.

Descriptors: *Sugar beets, *Crop response, Moisture, Plant growth, Plant tissues.

Existing methods for periodically measuring plant water status require considerable instrumentation or time. The method described herein simplifies plant water measurement by providing a completely linear calibration between attenuated beta radiation through a plant leaf and its relative water content simply by measuring the radiation intensity through the leaf at only two water contents - full turgidity and complete dryness.

75:021-013
THE RECOVERY OF LEAF WATER POTENTIAL, TRANSPIRATION, AND PHOTOSYNTHESIS OF COTTON DURING IRRIGATION CYCLES,
Bielorai, H., Hopmans, P.A.M.
The Volcani Center, Bet Dagan, Israel.
Agronomy Journal, Vol. 67, No. 5, p 629-632, September-October 1975. 6 fig, 1 tab.

Descriptors: *Moisture stress, *Transpiration, *Photosynthesis, *Cotton, Irrigation, Irrigation effects, Crop response, Crop production, Soil water.

The ability of a plant to recover from temporary and/or prolonged stress and the rate of recovery are of great importance in crop production. However, the information available on this subject is relatively scarce. A study was conducted to evaluate the recovery of irrigated cotton following soil moisture stress of various durations through the measurements of soil moisture stress using 1) the soil-moisture retention function, leaf water potential, by pressure bomb, and 2) leaf diffusion resistance by diffusive resistance porometer. Photosynthesis was measured by an infrared gas analyzer, and transpiration by weighing.

Section 8

WATER CYCLE

EROSION AND SEDIMENTATION (GROUP 02J)

75:02J-001
EROSION MODELING ON A WATERSHED,
Onstad, C.A., Foster, G.R.
Agricultural Research Service, Morris, Minnesota. North Central Soil Conservation Research Center.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 2, p 288-292, March-April 1975. 2 fig, 3 tab, 7 ref.

Descriptors: *Erosion rates, *Rill erosion, *Model studies, *Soil erosion, *Sediment yield, Watersheds (Basins), Sediment transport, Mathematical models, Runoff, Slopes, Sheet erosion, Surface runoff, Storm runoff, Deposition (Sediments), Iowa, Ohio.

An erosion-deposition model was described based on a modified form of the Universal Soil Loss Equation incorporating hydrologic variables. The sediment yield concept and computations involve calculating soil detachment potential and transport potential on a storm by storm basis and then comparing the two, resulting in sediment yields and deposition. All computations were made on a unit width basis and extended to the entire watershed, using an appropriate watershed transformation scheme. Calculations along the slope length were made on slope segments, each with different length and steepness. A procedure for estimating the relative contributions of rill and interrill erosion was also presented. The final result was an estimate of the rill and interrill erosion distribution on a watershed, indicating areas of severe erosion and deposition. The model was used to simulate the soil movement during 11 storms on two Midwest watersheds planted to contour corn. Predictions on the 82.8-acre Iowa watershed were better than those on the smaller 1.5 acre Ohio watershed.

75:02J-002
SIMULATION OF SOIL EROSION-PART I. DEVELOPMENT OF A MATHEMATICAL EROSION MODEL,
David, W.P., Beer, C.E.
International Rice Research Institute, Los Banos, Laguna (Philippines).
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 1, p 126-133, January-February 1975. 3 fig, 21 ref.

Descriptors: *Soil erosion, *Mathematical models, *Overland flow, *Precipitation intensity, *Raindrops, *Stream erosion, Sheet erosion, Rill erosion, Runoff, Suspended solids, Cultivation, Gully erosion, Model studies, Watersheds (Basins), Equations, Sediment transport, *Simulation analysis.

Results of a study conducted to simulate the process of sheet erosion by water were described. The primary objective of the study was to develop a mathematical model of erosion by water. The Kentucky Watershed Model was adopted to generate values of overland flow to be used in the erosion model. The other input to the precipitation. Equations expressing soil erosion from stream banks, impervious surfaces, and raindrop splash were developed. In addition, the carrying capacity of the overland flow was continuously evaluated to determine whether soil particles were being removed and transported from storage or deposited. The equations upon which the mathematical model was based are power functions with parameters that are to be evaluated during calibration runs of the model.

75:02J-003
SIMULATION OF SOIL EROSION-PART II. STREAMFLOW AND SUSPENDED SEDIMENT SIMULATION RESULTS,
David, W.P., Beer, C.E.
International Rice Research Institute, Los Banos, Laguna (Philippines).
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 1, p 130-133, January-February 1975. 3 fig, 3 tab, 8 ref.

Descriptors: *Simulation analysis, *Soil erosion, *Overland flow, *Precipitation intensity, *Sheet erosion, Mathematical models, Calibrations, Snowmelt, Suspended load, Stream erosion, Bank erosion, Scour, Streamflow, *Iowa, Model studies, Watersheds (Basins).

A sheet erosion model was developed to simulate sheet erosion from small agricultural watersheds. The sheet erosion model was used in conjunction with the Kentucky Watershed Model, which is a modified version of the Stanford Watershed Model. The Kentucky Watershed Model was modified and adapted to Iowa conditions. To evaluate the feasibility of the sheet erosion model, it was tested on the Four Mile Creek Watershed near Traer, Iowa. The simulated daily, monthly, and annual suspended sediment loads compared favorably to the observed values. It was mentioned that the sheet erosion model cannot be applied for large watersheds. The model also cannot predict the sediment deposition along floodplains and it lacks sufficient parameters to define the seasonal effect on some of the sheet erosion parameters.

75:02J-004
SOIL EROSION AND SEDIMENT TRANSPORT FROM GULLIES,
Piest, R.F., Bradford, J.M., Wyatt, G.M.
Agricultural Research Service, Columbia, Watershed Research Unit.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 101, No. HY1, Proceedings paper 11069, p 65-80, January 1975. 7 fig, 4 tab, 19 ref, 1 append.

Descriptors: *Erosion, *Gullies, *Mass wasting, *Sedimentation, *Tractive forces, Soil mechanics, Sediment transport, Watersheds (Basins), Soil conservation, Watershed management, Storm runoff, Hydraulics, *Iowa.

Field observations of four gullied watersheds, 75 acres to 150 acres in size, showed that gully erosion was one-fifth of the total sediment yield during a 9-yr period. Erosion rates were dependent upon mass wasting of loessial gully banks and headcuts. For the nonconservation watersheds, tractive forces exerted by runoff on the channel boundary did not detach appreciable amounts of undisturbed soil but were more than adequate to entrain the soil debris yielded by mass-wasting processes. Gully erosion was minimal on conservation watersheds; the runoff was generally below the levels required for gully debris removal, and the degree of slope was reduced to a stable value. Soil mechanics principles, applied to strength/stability aspects of gully banks in western Iowa, indicated that the height of the water table, soil cohesive strength, and rate of water infiltration are controlling factors. Initial field and laboratory model experiments provided insight into variables that affect the mass-wasting process. A large part of the gully soil debris accumulates during winter and early spring and is flushed from the channel with the first spring rainstorms. The relative quanities are greatly reduced for each subsequent runoff event during the year.

75:02J-005
FUNDAMENTAL ASPECTS OF EROSION OF COHESIVE SOILS,
Arulanadan, K.
California University, Davis.
Journal of the Hydraulics Division, Vol. 101, No. HY5, p 615-619, May 1975. 4 fig, 1 tab, 11 ref.

Descriptors: *Erosion, *Cohesive soils, Erosion rates.

The influence of soil systems at different dispersed states on the erodibility and swelling is well demonstrated. The degree of dispersion of the soil as influenced by mineralogy, amount of clay, SAR, concentration of pore and eroding fluids have to be considered in evaluating the erosion potentials of soils. For prediction of erodibility, a tentative relationship between CEC (a value which varies with or depends on the type of clay) and critical shear stress at a particular concentration of pore fluid at low and high values of SAR is presented. Experimental and theoretical investigation of erosion is in progress to obtain a functional relationship between structural parameters quantified in terms of electrical properties and erodibility.

75:02J-006
SOIL DETACHMENT FROM CLODS BY SIMULATED RAIN AND HAIL,
Hagen, L.J., Lyles, L., Dickerson, J.D.
Agricultural Research Service, United States Department of Agriculture, Kansas State University, Manhattan.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 3, p 540-543, May-June 1975. 2 fig, 5 tab, 10 ref.

Descriptors: *Rainfall, *Hail, *Rainfall intensity, Erosion, Cloud seeding, Thunderstorms.

Low energy hailfall, which commonly occurs in thunderstorms, can easily increase soil detachment from clods by 50 percent; at moderate intensities, it can double soil detachment over no hail. Increased soil detachment occurs when hail diameter exceeds about 0.75 cm. Hail less than 0.75 cm may slightly damage clods but it quickly covers the surface and protects against subsequent rain, wind, and hail damage. The process of soil detachment is complicated and depends on size and intensity of hail, windspeed, and surface cover as well as on interactions among these factors. Both seeding clouds to reduce hail size, if successful, and maintaining a mulch cover of at least 50 percent could substantially reduce soil detachment from clods.

75:02J-007
A MODEL FOR RUNOFF OF PESTICIDES FROM SMALL UPLAND WATERSHEDS,
Bruce, R.R., Harper, L.A., Leonard, R.A., Snyder, W.M., Thomas, A.W.
United States Department of Agriculture, Southern Region, Agriculture Research Service.
Journal of Environmental Quality, Vol. 4, No. 4, p 541-548, October-December 1975. 8 fig, 1 tab, 18 ref.

Descriptors: *Sediment load, *Pesticides, *Model studies, *Mathematical models, Rill erosion, Erosion, Water quality, Sediments.

A mathematical model has been developed describing the rate and quantity of runoff water from separate rainfall events on a watershed and the rate and quantity of sediment and pesticides transported. The runoff water is calculated by convolving an area-characteristic and variable state function to produce a variable response function which is then convolved with a computed effective rain. Rill and interrill erosion are conceptually distinguished which allows similar partitioning of associated pesticides. The sediment contribution from interrill erosion is a function of rainfall intensity and soil susceptibility to erosion. The rill erosion is a function of water runoff and the rate of change of water runoff. The concentrations of pesticides in the runoff are functions of the amount of runoff, the sediment concentrations derived from rill and interrill erosion, and the pesticide concentrations in the respective runoff-erosion zones. Experience with the model in simulating the water, sediment, and pesticide runoff from and upland Piedmont plain watershed for four summer storms is related. Excellent simulations were obtained.

75:02J-008
MEASURING WATER VELOCITY BY ULTRASONIC FLOWMETER,
Schuster, J.C.
Bureau of Reclamation, Denver, Colorado, Hydraulic Engineering, Hydrology Branch, Division of General Research, Engineering Research Center.
Journal of the Hydraulics Division Vol. 101, No. HY12 p 1503-1518, December 1975. 11 fig, 4 tab, 8 ref, 1 append.

Descriptors: *Erosion, *Infiltration, *Scour, Erosion control, Erosion rates, Bed load.

Ultrasonic flowmeters can be applied to measuring small and large flows in open-channel and closed-conduit systems. The accuracy of the measurement depends on positioning the transducers to measure a true average velocity in either open or closed-conduit flow. A measurement of 1% accuracy may be obtained by applying a correction factor to the velocity measurement from a single pair of transducers in a pipe having a fully developed turbulent velocity distribution. Possibly four pairs of transducers or a traversing pair are required for accurate measurements in a conduit or channel with unsymmetrical distribution. The metering method can be applied to flows varying over a wide range in open channels, to systems designed for a minimum head loss (such as power and pumping plants), to large-capacity turnouts that may require multiple Venturi meters to measure the flow range, and to systems having main supplies controlled by requiring electrical power should also consider the cost of supplying the power in evaluating the meters.

75:02J-009
LOCAL EROSION CAUSED BY RAPID FORCED INFILTRATION,
Willetts, B.B., Drossos, M.E.
Aberdeen University, Aberdeen, Scotland, Engineering.
Journal of the Hydraulics Division, Vol. 101, No. HY12, p 1477-1488, December 1975. 6 fig, 8 ref, 2 append.

Descriptors: *Erosion, *Infiltration, *Scour, Erosion Control, Erosion rates, Bed load.

Experiments were made in a 76-mm wide flume with a suction zone 76 mm by 125 mm in the base. In each run, the base of the flume, including the suction zone, was covered to a depth of 15 mm with grains of reasonably uniform size (as obtained by sieving) and a sufficient flow of water was introduced to transport bed load. Water was simultaneously extracted in the suction zone at a rate corresponding to 5%, 7.5%, 10%, and 12.5% of the streamflow rate upstream. Typically, a bed feature began to form in and beyond the suction zone, and each run continued until the feature attained a stable shape and size. Suction and streamflows were then stopped and the size of the bed feature measured.

75:02J-010
EFFECT OF FLOW RATE AND CANOPY ON RILL EROSION,
Meyer, L.D., Foster, G.R., Nikolov, S.
United States Department of Agriculture, Agricultural Research Service, Oxford, MS
Transactions of the American Society of Agricultural Engineers, Vol. 18 No. 5, p 905-911, September-October 1975. 7 fig, 3 tab, 10 ref.

Descriptors: *Rill erosion, Erosion, *Flow rate, Return flow, Erosion control, Canopy, Runoff.

Field studies were conducted to study the influence of flow rate on rill erosion. The data suggested that rill erosion does not begin until flow reaches a critical rate, and equations incorporating this concept were fitted to the experimental data. Observations and further analyses indicated that rill erosion might be separated into rill shear and rill headcut components with separate terms for each. Relationships using independently evaluated rill and interrill erosion components were compared with the relationship used for the slope-length factor in the Universal Soil Loss Equation. They agreed quite well for slope lengths up to about 45 m but diverged considerably at greater lengths.

75:02J-011
CONTROLLING RESERVOIR TRAP EFFICIENCY,
Rausch, D.L., Heinemann, H.G.
United States Department of Agriculture, Columbia, MO. Agriculture Research Service, Watershed Research Unit, North Central Region.
Transactions of the American Society of Agricultural Engineers, Vol. 18 No. 6, p 1105-1108, 1113, November-December 1975. 5 fig, 2 tab, 5 ref.

Descriptors: *Reservoirs, *Sedimentation, Runoff, Reservoir design, Reservoir operation, Reservoir releases, Water quality, Reservoir silting.

Research on three reservoirs in central Missouri has shown that reservoir sedimentation trap efficiency is affected by the detention time of storm runoff and by factors governing sediment particle size. Decreasing the detention time can be done by discharging storm runoff from the reservoir with the use of a bottom-withdrawal spillway. With the bottom-withdrawal spillway, the clean water remains in the reservoir and floats above the density currents caused by storm runoff moving to the deepest part of the reservoir.

75:02J-012
A STOCHASTIC MODEL OF DISPERSION OF SEDIMENT PARTICLES RELEASED FROM A CONTINUOUS SOURCE,
Todorovic, P.
Montreal University (Quebec). Department of Mathematics.
Water Resources Research, Vol. 11, No. 6, p 919-925, December 1975. 6 fig, 14 ref.

Descriptors: *Dispersion, *Stochastic processes, *Sediment transport, *Sediment discharge, *Sediment distribution, *Distribution patterns, Flow, Flow profiles, Sediments, Bed load, Suspended solids, Suspended load, Sediment load, Convection, Movement, Water pollution, Water pollution sources, *Path of pollutants, Mathematical studies, Statistical models.

The process of dispersion of bed sediment in streams has become a target for study because sediment may act as both a pollutant and a vehicle for soluble pollutants. Previous mathematical models of longitudinal dispersion of bed sediment described the behavior of a quantity of particles released simultaneously from a point or line source. The proposed model described the more common case of longitudinal dispersion of a quantity of sediment released gradually, at a known rate, during a specified time interval. Cases were examined for continuous release throughout finite and open-ended time intervals. Provided that certain regularity conditions hold, dispersion models may be obtained for both cases by simple integral transformation of the model for instantaneous release.

75:02J-013
PHYSICAL-CHEMICAL COMPOSITION OF ERODED SOIL,
Monke, E.J., Marelli, H.J., Meyer, L.D., DeJong, J.F.
Agricultural Engineering Department, Purdue University, West Lafayette, Indiana.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, December 15-18, 1975, Chicago, Illinois. 11 p, 3 fig, 5 tab, 7 ref.

Descriptors: *Runoff, *Particle size, *Erosion, *Erosion rates, Soil tests, Soil investigations, Soil erosion, Soil properties.

Water loss by runoff, soil loss in runoff, particle size distribution in the eroded soil material, and the water quality of runoff containing eroded soil materials were measured from soil surfaces subjected to simulated rainfall. Three soils from the Maumee River Basin under two extreme tilth conditions were selected.

75:02J-014
CONSERVATION OF SEDIMENT IN IRRIGATION RUNOFF,
Robbins, C.W., Carter, D.L.
Snake River Conservation Research Center, Agricultural Research Service, U.S.D.A., Kimberly, Idaho 83341.
Journal of Soil and Water Conservation, Vol. 30, No. 3, p 134-135, May-June 1975. 3 fig.

Descriptors: *Return flow, *Irrigation, *Irrigation effects, *Sediments, Sediment control.

Controlling sediment entering natural streams in irrigation return flow is a major economic and ecological challenge. A landowner often has little control over the management practices of his upstream neighbors. But he may be able to use sediment from runoff draining onto his land to improve the land's topography. In so doing he may reduce erosion on his land and simultaneously lower the downstream sediment load.

75:02J-015
EROSION IN 1973-74: THE RECORD AND THE CHALLENGE.
Grant, K.E.
Soil Conservation Service, U.S.D.A., Washington, D.C. 20250.
Journal of Soil and Water Conservation, Vol. 30, No. 1, p 29-32. January-February, 1975.

Descriptors: *Erosion, *Crop production, *Agriculture, *Soil conservation.

The 1973-74 growing season in many ways was not a good one for the nation's soil and water resources. Excessive soil erosion from both wind and water accompanied the efforts of many farmers to increase crop production. Contributing to the year's poor record was some of the worst weather in years. But severe erosion could also be traced to the unwise selection of certain soils for cultivated crops as well as the existence of too few conservation measures on the land.

75:02J-016
IOWA'S EXPERIENCE WITH A MANDATORY SEDIMENT CONTROL LAW.
Greiner, W.H.
Iowa Department of Soil Conservation, Des Moines 50319.
Journal of Soil and Water Conservation, Vol. 30, No. 3, May-June 1975. p 132-134.

Descriptors: *Sediment control, *Sediments, *Legislation, Iowa, Erosion, Erosion control, Soil erosion.

Before the mid-1960s, sediment control laws were seldom a topic of conversation in Iowa, but a chain of events took place that brought these words into prominence. Iowa was one of the first states to enact a sediment control law. Many people refer to the law as landmark legislation because no other state has a law that deals with soil erosion to the extent this one does. The law surely has had an impact on conservation district programs in Iowa, but it is in no sense a model law. Compromises preceded its enactment. As a result, some sections of the law are not as strong as they could be.

75:02J-017
A COMPARISON OF NITROGEN, PHOSPHORUS, AND CARBON IN SEDIMENTS AND SOILS OF CULTIVATED AND NONCULTIVATED WATERSHEDS IN THE NORTH CENTRAL STATES.
Ritchie, J.C., Gill, A.C., McHenry, J.R.
USDA, Sedimentation Laboratory, Alabama-North Mississippi Area in Cooperation with Mississippi University.
Journal of Environmental Quality, Vol. 4, No. 3, 1975. p 339-341, 5 tab, 12 ref.

Descriptors: *Nitrogen, *Phosphorus, *Carbon, *Return flow, Water quality, Sediments, Nutrients, Nutrient removal, Cultivation, Cultivated lands, Watersheds (Basins).

Soil and sediments from six cultivated watersheds and from six noncultivated watersheds were sampled and the concentration of nitrogen, phosphorus, and carbon was determined. No significant difference was found in the concentration of N, P, or C with depth in the soils or sediments. Concentration of N, P, and C were not significantly different in the soils and sediments of the cultivated watersheds; however, the sediments of the noncultivated watersheds had significantly less N and organic P than the watershed soils. Less accumulation of N, P, and C is occurring in the noncultivated watershed sediments than in the cultivated watershed sediments. These data indicate that sediment source is probably an important factor in determining N, P, and C concentration in reservoir sediments.

75:02J-018
EVALUATION OF AGRICULTURAL POLICY ALTERNATIVES TO CONTROL SEDIMENTATION.
Seitz, W.D., Sands, M.B., Spitze, R.G.F.

Department of Agricultual Economics, Illinois University, at Urbana-Champaign, Illinois.
Final Report to the Office of Water Research and Technology, U.S. Department of the Interior, February 1975. Washington, D.C. Report No. 99, 111 p, 10 fig, 28 tab, 57 ref.

Descriptors: *Erosion, *Sedimentation, *Linear programming, Crop production, Soil conservation, Soil erosion, Sediments.

Alternative policies for reducing the level of erosion and sedimentation are evaluated with a linear programming analysis of farms in a selected watershed. Three conservation practices and three tillage practices are considered in combination with six crop rotations on approximations of nine actual farms located in representative sections of the watershed. The impact of these practices on crop production costs and yields is considered, as is the impact on the off-site damages to the drainage system and the reservoir. Policies considered include subsidization of the cost of adopting conservation practices and subsidies to induce removing land from production, several forms of regulations and an effluent tax. Where appropriate the policies were analyzed assuming implementation at both the watershed and the farm level. This analysis indicates that soil conservation practices should be increased substantially in order to reduce the gross soil loss in the watershed from over 20 to approximately 6 tons per acre per year. This reduction is most efficiently accomplished by modifying conservation practices, tillage practices, and crop rotations. An important finding is the indication that several alternative policies can be applied at either the watershed or the farm level and without regard to the farms' proximity to the reservoir, with very little difference in results.

75:02J-011
A SUBMODEL FOR NITROGEN RELEASE FROM SEDIMENTS,
Jacobsen, O.S., Jorgensen, S.E.
Ferskvandsbiologisk Laboratorium, Helsingorsgade, Hillerod (Denmark).
Ecological Modelling, Vol. 1, No. 2, p 147-151, July 1975. 1 fig, 2 tab, 2 equ, 18 ref.

Descriptors: *Model studies, *Nitrogen, Nutrients, Sediments, Anerobic, Aerobic, Organic matter, Fertilization.

A submodel for the aerobic and anaerobic nitrogen release from sediment is set up. It was found that the rate of nitrogen release, R is correlated to the nitrogen content by the following equations: R sub AN=84S sub N + 1.6 (anaerobic); R sub AE=58S sub N + 1.9 (aerobic); where: S sub N is mg N/ml in the sediment. The influence of temperature is included by use of an exponential expression, since the release is governed by a biochemical decomposition of organic matter.

WATER CYCLE

CHEMICAL PROCESSES (GROUP 02K)

75:02K-001
LANDFORM-SOIL-VEGETATION-WATER CHEMISTRY RELATIONSHIPS, WRIGLEY AREA, N.W.T.:
I. MORPHOLOGY, CLASSIFICATION, AND SITE DESCRIPTION,
Walmsley, M.E., and Lavkulich, L.M.
British Columbia University, Vancouver, Department of Soil Science.
Soil Science Society of America Proceedings, Vol 39, No. 1, p 84-88, January-February 1975. 3 fig, 1 tab, 12 ref.

Descriptors: *Soil-water-plant relationships, *Water chemistry, *Permafrost, *Canada, Geomorphology, Alpine, Soil types, Soil horizons, Regolith, Bogs, Lichens, Vegetation, Arctic.

Five landforms occurring in the intermittent permafrost region of the Mackenzie Valley were described. The five landforms, consisting of distinct soil and vegetative characteristics occur on a transect from the 1170 m ASL (above sea level) position at the summit of Cap Mountain, Wrigley area, Northwest Territories, to approximately 500 m ASL at the base of the slope. Two soils meet the requirement of a histic epipedon. An area of stone stripe and stone ring formation was encountered at approximately 1060 m ASL and an extensive area of lichen-covered polygonal bogs occurred at approximately 760 m ASL. The soils were described in relation to environmental factors and the processes of cryoturbation causing intermittent horizons were discussed.

75:02K-002
DETERMINATION OF TOTAL NITROGEN IN NATURAL WATERS,
Nelson, D.W., Sommers, L.E.
Purdue University, Lafayette, Indiana Department of Agronomy.
Journal of Environment Quality, Vol. 4, No. 4, p 465-468, 1975, 6 tab, 9 ref.

Descriptors: *Analytical techniques, *Methodology, *Water analysis, *Nitrogen, Vapor compression distillation, Nitrogen compounds, *Pollutant identification.

Total nitrogen determinations in natural waters are complicated because numerous forms of nitrogen are present. Nitrates are frequently present in substantial amounts and require pretreatment to be quantitatively reduced to ammonia, which is measured by the Kjeldahl nitrogen method. Nitrate recovery from plant materials, fertilizers, and soils succeed when samples are pretreated with reduced iron in acid media. Hydrogen generated by the iron-with-acid reaction apparently acts as a reducing agent. In the proposed method water samples are evaporated and pretreated with reduced iron and sulfuric acid, followed by Kjeldahl digestion to recover organic nitrogen. Ammonia in the digestion mixture is estimated by steam distillation and titration. Nitrate and organic nitrogen recovery is affected by the brand and amount of reduced iron used and boiling the sample gently with reduced iron and sulfuric acid before digestion. The method measures up to 2 mg total nitrogen and 0.5 mg nitrate nitrogen in filtered or unfiltered river and pond waters. It is simple, precise, more rapid than other methods, and can measure all forms of nitrogen commonly found in natural and waste waters. Organic nitrogen can be calculated by subtracting inorganic nitrogen from the total nitrogen found.

75:02K-003
REGIONAL HYDROCHEMISTRY OF NORTH AMERICAN CARBONATE TERRAINS,
Harmon, R.S., White, W.B., Drake, J.J., Hess, J.W.
McMaster University, Hamilton (Ontario), Department of Geology.
Water Resources Research, Vol. 11, No. 6, p 963-967, December 1975. 2 fig, 4 tab, 27 ref.

Descriptors: *Carbonates, *Water chemistry, Groundwater, *Geochemistry, *North America, Geographical regions, Carbonate rocks, Dolomite, Limestones, Carbon ioxide, Climates, Temperature, Chemistry, Bicarbonates, Hydrogen ion concentration, Calcite, Water quality, Spring waters, Ions, Hydrogeology, Variability, Water temperature, Seasonal, Saturation.

The chemical variation of water samples drawn from carbonate terrains between southern Canada and northern Mexico was shown to be divisible into, first, variations at the local level due to (1) hydrogeologic conditions (time independent), (2) short-term fluctuations of hydrologic factors (stochastic in time), and (3) seasonal fluctuations of such factors as temperature, precipitation, and plant growth (systematic in time) and, second, regional climatic effects. These regional climatic effects can be satisfactorily represented by mean annual groundwater temperature variation. The regional variation only emerges clearly if care is taken to compare water samples from the same hydrologic class, in this case, springwater. The partial pressure of carbon dioxide with which a springwater sample is in equilibrium is well represented by log P sub CO2=a+bT, where a is of the order of -3.5 and b is approximately 0.07 with P sub CO2 in atmospheres and T in degrees Celsius.

75:02K-004
THE SOLUBILITY OF FERRIC OXYHYDROXIDES IN NATURAL WATERS,
Whittemore, D.O., Langmuir, D.
Kansas State University, Manhattan. Department of Geology.
Ground Water, Vol. 13, No. 4, p 360-365, July-August 1975. 1 fig, 4 tab, 22 ref.

Descriptors: *Solubility, *Iron compounds, *Water properties, *Iron oxides, *Water chemistry, Physical properties, Chemical properties, Phase diagrams, Saturation, Oxidation-reduction potential, Chemical reactions, Geochemistry, Oxides, Hydrogen ion concentration, Chemical potential, Water.

Iron in groundwater is often present both in solution and as suspended ferric oxyhydroxides. In most instances amounts of dissolved iron in natural waters are limited by the solubility of the ferric oxyhydroxides, whether suspended or present as part of aquifer materials. Oxyhydroxide solubilities, which range widely in natural waters, may be described by pQ = -log (Fe+++) (OH-)(OH-)(OH-), where (Fe+++)(OH-)(OH-)(OH-) is the product of ion activities in the water. pQ values calculated from Fe(II), Eh, and pH measurements in several types of high iron ground and surface waters (Fe(II) = 0.02 to 1460 ppm) indicate that most of the waters are in equilibrium with ferric oxyhydroxides which range from amorphus material to crystalline goethite (pQ values at 25C from about 37 to 44, respectively. Stabilities generally increase (higher pQ's) in a given water with time. In general, the lower the dissolved iron, the more soluble is the oxyhydroxide precipitated and the slower its increase in stability. This was observed both in coastal-plain groundwaters (pQ = 36.6 - 42.7), and in laboratory aged solutions. The faster the oxidation and hydrolysis rate of dissolved Fe(II), the lower the pQ, as shown by the reaction of mineralized spring waters with varying amounts of surface waters (pQ = 37.2 - 41.5).

75:02K-005
CHEMICAL WEATHERING OF GLAUCONITE,
Abudelgawad, G., Page, A.L., Lund L.J.
Tripoli University, Tripoli, Libya.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 567-571, May-June, 1975. 3 fig, 2 tab, 26 ref.

Descriptors: *Chemical reactions, *Geologic investigations, Geological surveys.

Glauconite samples were collected from geologic cuts in the Barce Plateau in the eastern part of Libya. The glauconite was associated with limestone, dolomitic limestone, marl, marl stone, chert, and kaolinite. Samples of the glauconite from the area of study after removal of carbonates gave x-ray diffraction spacings of 10.0, 7.2, 5.0, 3.6 and 3.3 Angstroms. Spacings of 10.0, 5.0, and 3.3 Angstroms represent the 001, 002, and 003 reflection of micaceous components. Spacings of 7.2 and 3.6 Angstroms were due to kaolinite. No 060 reflection was observed for random samples. The absence of this spacing, although not entirely specific for glauconite, is indicative of glauconite-like minerals. Petrographic analysis and chemical composition confirmed that the micaceous mineral studied was glauconite.

75:02K-006
THE ACTIVITY CONCEPT OF PHOSPHATE-ROCK SOLUBILITY,
Chien, S.H., Black, C.A.
International Fertilizer Development Center, Florence, Alabama 35630,
Soil Science Society of America Proceedings, Vol. 39, No. 5, p 856-858, September-October 1975. 4 fig, 11 ref.

Descriptors: *Phosphate, *Soil chemistry, Soil investigations, Chemical reactions.

Variously treated samples of a finely ground Florida phosphate rock were equilibrated with dilute HCl solutions, and the ion-activity product of the carbonate apatite mineral in the phosphate rock was then determined from analyses made on the solutions. Constant ion-activity products or solubility-product constants were found within a certain pH range in each instance. The solubility, as reflected by the numerical value of the constant, decreased with an increase in the proportion of the phosphate rock dissolved in the solubility determination or prior thereto. After a certain portion of the phosphate rock had been dissolved, however, no further decrease in solubility was found with further extraction of the phosphate rock. These results are similar to those obtained previously with synthetic hydroxyapatite and were interpreted in the same way, namely, that the solids are not uniform but exist in a range of activities.

75:02K-007
THE CHEMISTRY OF LEAD AND CADMIUM IN SOIL: SOLID PHASE FORMATION,
Santillan-Medrano, J., Jurinak, J.J.
Soil Science Society of America Proceedings, Vol. 39, No. 5, p 851-856, September-October 1975. 8 fig, 2 tab, 14 equ, 17 ref.

Descriptors: *Lead, *Cadmium, *Soil investigations, Soil chemistry, Chemical reactions.

Equilibrium batch studies were conducted to obtain solubility data of Pb and Cd in soils. The data were plotted on equilibrium solubility diagrams using pH as the master variable. In the construction of the diagram the hydroxide, carbonate, and phosphate compounds of Pb and Cd were given particular attention. Both Pb and Cd solubility decreased in the soils as pH increased. The lowest values were obtained in the calcareous soil. Under a given set of conditions, however, Cd activity in solution was always notably greater than that of Pb.

75:02K-008
THE MECHANISM OF PHOSPHATE FIXATION BY IRON OXIDES,
Parfitt, R.L., Atkinson, R.J., Smart, R.St.C.
Griffith University, Nathan, Brisbane Australia 4111.
Soil Science Society of America Proceedings, Vol. 39, No. 5, p 837-841, September-October 1975. 6 fig, 1 tab, 12 ref.

Descriptors: *Iron oxides, *Iron, *Phosphates, Soil chemistry, Soil investigations, Chemical reactions.

Infrared spectroscopic techniques have been used to obtain a structural model for the surface reaction between iron oxides and phosphate ions. Two surface hydroxyl ions (or water molecules) are replaced by one phosphate ion. Two of the oxygen atoms of the phosphate ion are coordinated, each to a different Fe3+ ion, resulting in a binuclear surface complex of the type Fe-O-P(O2)-O-Fe. Evidence is given for phosphate adsorption producing this coordination structure on the surfaces of goethite, hematite, lepidocrocite, beta-ferric hydroxide, and amorphous ferric hydroxide gel.

75:02E-009
THE IMPACT OF MAN ON THE WORLD NITROGEN CYCLE,
McCarl, B.; Raphael, D.; Stafford, E.
Purdue University, Department of Agricultural Economics,
Journal of Environmental Management, Vol. 3, No. 1, p. 7-19, January 1975.

Descriptors: *Nitrogen, *Atmosphere, Model studies, Chemical reactions.

The atmosphere is a complex chemical system in which nitrogen emissions, resulting from man's occupancy of the earth, mixes and interacts with natural nitrogen emissions. By examining the flow of nitrogen within the world, it is possible to improve our understanding of how man's emissions affect the natural nitrogen cycle. Obviously the direct effects of man's nitrogen emissions are multiplied by the natural cycle. This paper attempts to get a hold upon the multiplier effect. Through the use of input-output methodology a system with homogeneous flow may be analysed, finding the multiplier effects. Homogeneous flow is obtained in the nitrogen cycle by converting all flows into their accompanying nitrogen content. The system is then modelled and a solution derived. The impact of one ton of man's nitrogen input is then seen to produce some 803 tons of flow.

75:02E-010
NITROGEN TRANSFORMATIONS IN SOIL AS AFFECTED BY THE FUNGICIDES BENOMYL, DYRENE, AND MANEB,
Mazur, A.R.; Hughes, T.D.
Clemson University, Clemson, SC 29631
Agronomy Journal, Vol. 67, No. 6, p 755-758, November-December. 2 fig, 2 tab, 16 ref.

Descriptors: *Fungicides, *Nitrogen, *Fertilization, *Fertilizers, *Nitrification.

The frequency and extent of fungicide use on putting green turfgrasses prompted investigations to determine the effect of three commonly used fungicides on N transformations in soil. Laboratory and field studies were conducted to study the effect of the following fungicides on nitrification and N mineralization in soil. The differences in the effects of these fungicides on nitrification and N mineralization in laboratory as compared to field applications were considered to be the result of lower rates of application associated with more rapid rates of degradation under field conditions as contrasted with the high single rates of application under laboratory conditions.

75:02E-011
RATE OF DISSOLUTION OF PHOSPHATE FROM MINERALS AND SOILS,
Olsen, R.A.
Montana State University, Bozeman, Montana 59715.
Soil Science Society of America Proceedings, Vol. 39, No. 4, p 634-639, July-August 1975. 5 fig, 3 tab, 5 equ, 19 ref.

Descriptors: *Phosphate, Nutrients, Soil investigations, Laboratory tests.

A laboratory technique was devised for conveniently measuring the rate of dissolution of phosphates in minerals and soils. The conditions imposed upon the samples were believed to be similar in several important respects to those in the close proximity of plant roots. An equation was derived which was reasonably descriptive of the dissolution process even in widely different soils. The technique was used to measure the rate of dissolution of a number of well-characterized rock phosphate samples and of many soils. The data were found to rate the samples very well with regard to their value as a source of phosphate to plants.

75:02E-012
NITROGEN FIXATION BY ALGAE IN FESCUEGRASS SOIL CRUSTS,
Reddy, G.B.; Giddens, J.
Georgia University, Agricultural Experiment Stations, Athens, 30602.
Soil Science Society of America Proceedings, Vol. 39, No. 4, p 654-656, July-August

1975. 1 Fig, 2 tab, 21 ref.

Descriptors: *Grasses, *Subsoil, *Nitrogen fixation, Nitrogen, Nutrients, Algae, Fertilization, Carbon.

Soil crusts and subsoil samples of different ages of tall fescuegrass were collected and analyzed for N,C, and acetylene reduction. Total N and C in the crust was 0.18% and 2.78%, respectively, in 4-year old soil crust as compared to 0.08% and 0.67% respectively, in fallow soil. The amount of acetylene reduction after 5 days' incubation was 11.77 micro-mole/flask (9.6 cm2) for the 4-year-old sod crust compared to 1.08 micro-mole/flask for the fallow control. Ammonium nitrate reduced and liming increased N fixation in the crust. Nitrogen fixation in the crust was highest at 55% shade. Greater nitrogen fixation occurred when moss was present in crust.

75:02K-013
THE EFFECT OF AMMONIA AND AMMONIA-SULFUR SOLUTIONS ON NITRIFICATION RATES AND CHEMICAL PROPERTIES OF A CALCAREOUS SOIL,
Stevens, R.G., Reuss, J.O.
Texas Tech University, Lubbock, Texas 79409.
Soil Science Society of America Proceedings, Vol. 39, No. 4, p 787-793, July-August 1975. 7 Fig, 2 tab, 4 equ, 25 ref.

Descriptors: *Nitrification, *Soil chemistry, *Soil chemical properties, *Chemical properties, Ammonia, Soil properties, Nitrate, Nitrite, Sulfur.

Nitrification rates and changes in chemical properties of a calcareous soil were investigated after injection of liquid anhydrous NH3 and anhydrous NH3-S solutions. Nitrification rates (on a whole pot basis) of 15.7, 24.3, and 32.2 mg of N per pot per day were found with the application of 200, 400, and 600 mg of N/pot, respectively. These nitrification rates were recorded during the initial 14 days of the study when total NO3- accumulation appeared to be linear.

75:02K-014
DISSOLUTION OF ILLITE--A POSSIBLE MECHANISM OF POTASSIUM RELEASE,
Feigenbaum, S., Shainberg, I.
Institute of Soils and Water, Agricultural Research Organization, The Volcani Center, Bet Dagan, Israel.
Soil Science Society of America Proceedings, Vol. 39, No. 5, p 985-990, September-October 1975. 3 Fig, 2 tab, 13 equ, 18 ref.

Descriptors: *Potassium, *Aluminum, *Iron, *Magnesium, Illite, Chemical reactions.

The rate of potassium, aluminum, iron and magnesium release from Fithian illite in dilute salt solutions and at pH = 7, was studied. It was found that cumulative cation release was proportional to the square root of the duration of the treatment. The rate of Al release was similar to the rate of K release, whereas the rate of Fe and Mg release was about three x that of K and Al release. Since the only known mechanism for the release of the lattice cations is the dissolution of the clay, it is proposed that dissolution of the clay lattice is also the dominant mechanism by which potassium is released from the clay. Two consecutive reactions, a rapid exchange reaction and a slow first-order reaction, explain the experimental observations.

75:02K-015
FIXATION OF IRON AND ZINC APPLIED AS CHELATES INTO A SOIL COLUMN DURING LEACHING,
Lahav, N., Hochberg, M.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1213-1215, November-December 1975. 4 Fig, 1 equ, 5 ref.

Descriptors: *Iron, *Zinc, *Leaching, Infiltration, Soil investigations.

The movement of iron in the form of FeEDDHA and FeEDTA and zinc in the form of ZnEDTA was studied in columns of Rehovot sand under several flow rates and in the presence of either Ca(NO3)2 or KNO3 with the same ionic strength of 0.0175M/liter. Chloride was used as a tracer. FeEDDHA was neither adsorbed nor fixed by the soil. Both ZnEDTA and FeEDTA were fixed in the soil column in the presence of Ca2+ but not in the presence of K+. ZnEDTA was not adsorbed significantly, whereas FeEDTA was adsorbed in the presence of either KNO3 or Ca(NO3)2 solutions. Reasonable agreement was obtained between experimental results and theoretical calculations of the breakthrough curves, based on the analytical solution of the general dispersion equation.

75:02G-016
POTASSIUM IN AN ARID LOESSIAL SOIL: CHARACTERIZATION BY EQUILIBRIUM RELEASE-ABSORPTION TO STRONG SALT SOLUTIONS,
James, D.W., Weaver, W.H.
Utah State University, Logan 84322.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1106-1111, November-December 1975. 6 Fig, 1 tab, 24 ref.

Descriptors: *Potassium, Soil chemistry, Soil investigations, Sodium, Magnesium, Calcium, Absorption.

Shano silt loam soil developed from loessial and volcanic materials of recent origin under mild weathering conditions. It contains less than 5% of clay, and 60% or more of silt. The rate of release of mineral K (Km) in this soil to 1N Cl solutions decreased in the order Na greater than Ca greater than Mg much greater than NH4. Release of Km may have involved some framework silicates, but for practical purposes the layer silicates controlled Km activity.

75:02G-017
EFFECT OF ADDED SALTS ON NITROGEN RELEASED AND NITRATE LEVELS IN FOREST SOILS OF THE WASHINGTON COASTAL AREA,
Heilman, P.
Western Washington Research and Extension Center, Puyallup, WA. 98371.
Soil Science Society of America Proceedings, Vol. 39, No. 4, p 778-782, July-August 1975. 2 Fig, 4 tab, 20 ref.

Descriptors: *Nitrogen, *Nutrients, Salts, Salinity, Nitrate, Nitrification.

The release and mineralization of N was studied in incubated samples of 10 forested soils from the Washington Coast which had been treated with a variety of salts. Salts were added in solution at 0.005, 0.05, and 0.2M concentrations and the samples were incubated at 27C for 7, 14, and 21 days. Release of NH4-N plus NO3-N increased with increase in the duration of incubation and concentration. The lowest concentration of salt increased N release over that from distilled water.

75:02G-018
EFFECT OF TEMPERATURE ON DENITRIFICATION RATE IN SOILS,
Stanford, G., Dzienia, S., Vander Pol, R.A.
Academy of Agriculture, Institute of Soil and Plant Cultivation, Szczecin, Poland.
Soil Science Society of America Proceedings, Vol. 39, No. 5, p 867-870, September-October 1975. 3 Fig, 1 tab, 12 ref.

Descriptors: *Denitrification, *Temperature, Soils, Soil investigations, Organic matter, Soil chemistry, Nitrogen, Nutrients.

The effect of temperature on denitrification rate was studied with nine soils differing widely in organic matter content and chemical and physical characteristics. In the ragne of 15 to 35C, the temperature coefficient of denitrification, Q10, was approximately 2. Denitrification rates at 35 and 45C were similar. Between 10 and 5C, denitrification rate declined abruptly. The lower limit of the temperature range conforming to a Q10 of 2 was estimated to be 11C. In this study of water-logged soils sealed from the atmosphere, denitrification appeared to obey first-order kinetics.

75:02B-019
POTASSIUM-CALCIUM EXCHANGE EQUILIBRIA IN VOLCANIC-ASH SOILS,
Schalscha, E.B., Pratt, P.F., de Andrade, L.
University of Chile
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1069-1072,
November-December 1975. 3 fig, 5 tab, 12 ref.

Descriptors: *Potassium, *Calcium, Soils, Soil investigations, Soil chemistry, Chemical reactions.

Potassium-Ca exchange equilibria were determined at potassium adsorption ratios (PAR) of 0.2, 2.0, and 20 for pH values of 4.8, 6.0, and 7.5 for four volcanic-ash soils of southern Chile. Increases in pH produced large increases in CEC which were largely balanced by increases in the amount of Ca adsorbed. The increases in exchangeable K with increase in CEC were relatively small. The relative affinities for K versus Ca at a PAR of 0.2 indicated that for each soil a small, but nearly constant, amount of negative charge had a high specificity for K. Beyond this small amount of CEC with a high affinity for K, the affinities for K were relatively low.

75:02B-020
ENVIRONMENTAL IMPLICATIONS OF N FIXATION BY SOYBEANS,
Johnson, J.W., Welch, L.F., Kurtz, L.T.
Illinois University, Urbana, IL. Department of Agronomy.
Journal of Environmental Quality, Vol. 4, No. 3, 1975. p 303-306, 3 fig, 2 tab,
7 ref.

Descriptors: *Nitrogen, *Nitrogen fixation, *Soybeans, Crop production, Corn, Crop response, Fertilizers, Fertilization, Nutrients.

The objective was to measure inorganic N removal from soil by soybeans grown at different N levels. Nodulating and non-nodulating isolines of 'Clark' soybeans were planted on Flanagan silt loam in 1972 and 1973. Fertilizer rates of 0, 112, 224, and 448 kg N/ha as Ca(NO3)2 enriched with 1% 15N were applied. Symbiotically fixed N decreased from 48 to 10% of the total N in the above-ground plant as applied fertilizer N increased from 0 to 448 kg/ha. Net removals of N by soybean grain were 61, 109, 135, and 149 kg/ha at 0, 112, 224, and 336 kg/ha, respectively. The study indicates that soybeans are good scavengers for inorganic N in soils.

Section XII

WATER CYCLE

ESTUARIES (GROUP 02L)

76:02L-001
EXPANSION OF SALT-WATER ZONE DUE TO WELL DISCHARGE,
Kashef, A-A. I.; Smith, J.C.
North Carolina State University, Raleigh. Department of Civil Engineering.
Water Resources Bulletin, Vol. 11, No. 6, p 1107-1120, December 1975. 7 fig, 4 tab, 10 ref.

Descriptors: *Saline water-freshwater interfaces, *Water wells, *Saline water intrusion, Coasts, Aquifers, Pumping, Aquifer characteristics, Computer models, Water management(Applied), Groundwater movement, Hydraulic conductivity, Specific weight, Potentiometric level, Equations, Natural flow, Theis equation, Storage coefficient, Groundwater, Saline water, Wells.

In coastal confined aquifers, the extent of saltwater wedge due to natural groundwater flow can be determined by available methods. If water is pumped by a discharge well, the quality of the water depends upon the rate and duration of pumping as well as the location of the well. A study was made to find the extent of the progress of salt-water intrusion due to the operation of one discharge well, taking into account various conditions of aquifer properties, pump capacities, natural flow, time effects, and well locations. Dimensionless solutions for specific conditions were obtained by means of a simple computer program. Range of most common conditions was discussed. One of the main findings of the study was that salt water may be pumped out of a well even if it is located in an initially totally fresh-water zone beyond the natural salt/fresh-water interface.

Section XIII

WATER SUPPLY AUGMENTATION AND CONSERVATION

WATER YIELD IMPROVEMENT (GROUP 03B)

75:03B-001
PREDICTING REDUCTION IN WATER LOSSES FROM OPEN CHANNELS BY PHREATOPHYTE CONTROL,
Bouwer, H.
Agricultural Research Service, Phoenix, Arizona. Water Conservation Laboratory.
Water Resources Research, Vol. 11, No. 1, p 96-101, February 1975. 7 fig, 2 tab, 16 ref.

Descriptors: Phreatophytes, *Water loss, *Open channels, Channels, Seepage, Water tables, *Flood plains, Streams, Evapotranspiration, Groundwater, Vegetation, Evaporation.

A procedure was presented for calculating seepage from a stream due to uptake of groundwater by vegetation or evaporation from soil in the floodplain. The calculation required that the relation between evapotranspiration rate and water table depth be known. When these relations were available for a given floodplain before and after removal of phreatophytes, the reduction in seepage losses from the stream due to phreatophyte removal could be computed. To simplify the calculation process, the curves relating evapotranspiration rate and water table depth, which are generally sigmoid (curved in two directions), could be approximated by step functions of the same area. Potential water savings by phreatophyte control were calculated for step functions that were representative of deep-rooted vegetation, shallow rooted vegetation, and bare soil. In addition to the depth from which groundwater could be evaporated before and after phreatophyte removal, the water savings were affected by the vertical distance between the water level in the stream and the floodplain.

75:03B-002
INFILTRATION AND RUNOFF FOR SMALL FIELD PLOTS UNDER CONSTANT INTENSITY RAINFALL,
Swartzendruber, D., and Hillel, D.
Hebrew University, Rehovoth (Israel). Department of Soil and Water Science.
Water Resources Research, Vol. 11, No. 3, p 445-451, June 1975. 6 fig, 1 tab, 9 ref, 1 append.

Descriptors: *Infiltration, *Runoff, *Field crops, *Rainfall, Infiltrometers, Soil surfaces, Rainfall intensity, Simulated rainfall.

A relatively simple infiltration equation was used to express the family of infiltration flux time curves that occurred under constant rate water application (sprinkling or rain) from the time that excess water appeared at the soil surface. The equation was easily integrated for cumulative water excess as a function of time, which in turn allowed taking into account a simplified static surface volume to calculate cumulative water runoff. The runoff equation so obtained was tested by means of a sprinkling infiltrometer used on plots of 1 sq m and was found to express with good accuracy the measured cumulative plot runoff as a function of time. The field data, taken with a modified Purdue-Wisconsin sprinkling infiltrometer on Rehovot loamy sand, were then utilized successfully for obtaining the ultimate steady infiltration flux, even when the period of measuring transient runoff was less than 1 hour and the total runoff less than 1 cm of water. The value of steady flux so obtained was in good agreement with that found under the condition of continuous ponding of water on the soil surface.

75:03B-003
WIND EFFECTS ON CHEMICAL FILMS FOR EVAPORATION SUPPRESSION AT LAKE HEFNER,
Crow, F.R., and Mitchell, A.L. Jr.
Oklahoma State University, Stillwater. Dept. of Agricultural Engineering.
Water Resources Research, Vol. 11, No. 3, p 493-495, June 1975. 4 fig, 5 ref.

Descriptors: *Evaporation control, *Winds, *Films, *Lakes, *Oklahoma, Evaporation, Hexadecanol, Octadecanol, Slurries, Application equipment, Application methods, Retardants, Thin films, Research and development, Alcohols, Rates of application, Wind velocity.

An evaporation suppression research project was conducted at Lake Hefner, Oklahoma, where water-based slurries of hexadecanol and octadecanol were applied at the upwind side of the lake by an offshore sprinkler system. The distribution system was designed for maximum film cover under south winds. The chemical was applied at a variable rate adjusted to the demand created by local wind speed and direction. The application rate required to replace film removed by the wind, in terms of pounds per hour per foot of distribution line perpendicular to the wind, averaged 5.2-8 times greater than for an experimental pond with a similar application system. The upper wind speed limit for successful film application was 13 miles per hour (mph). Distribution studies were made to determine the percent of time that wind speeds and directions were favorable to the application of film, i.e., with speeds less than 13 mph and direction between 135 degrees and 225 degrees azimuth. Under wind conditions experienced in Oklahoma it was difficult to maintain continuous film cover because of the frequency of occurrence of high wind speeds and shifts in wind direction.

75:03B-004

ANALYSIS OF FLOW THROUGH VEGETATION,

Petryk, S., Bosmajian, G. III
Florida University, Gainesville, Florida, Department of Civil and Costal Engineering.
Journal of the Hydraulics Division Vol. 101 No. HY7 p 871-884, July 1975. 9 fig, 15 ref, 2 append.

Descriptors: *Flow, *Flow characteristics, Open channel flow, Open channels, Hydraulics, Vegetation, Vegetation effects.

A flow resistance model for unsubmerged vegetation conditions is presented. It is quantitatively described by Eq. 12, which predicts the n value in terms of vegetation density, the hydraulic radius, and the Manning bottom roughness value without the vegetation for the special case of a uniform density of vegetation with height, applicable to some heavily treed flood plains. The Mannings n value increases in proportion to the 2/3 power of the hydraulic radius. This assumes that the flow occurs through heavily vegetated areas where the total shear force on the channel boundary is negligible compared to total drag force on the vegetation.

75:03B-005

WORKSHOP FOR AN ASSESSMENT OF THE PRESENT AND POTENTIAL ROLE OF WEATHER MODIFICATION IN AGRICULTURAL PRODUCTION,

Grant, L.O., Reid, J.D.
Department of Atmospheric Science, Colorado State University, Fort Collins, Colorado 80523.
Compilation of Workshop Materials of Workshop held at Colorado State University, July 15-18, 1975. 235 p, 22 fig, 13 tab, 53 ref.

Descriptors: *Weather, *Weather modification, *Agriculture, *Weather patterns, Rainfall, Crop production.

The broad objective of the assessment of the present and future role of weather modification in agricultural production is to make an authoritative evaluation of the present and potential role that weather modification can take in increasing national and world agricultural production. A specific objective includes the preparation of an authoritative document that can receive wide distribution and provide for extensive utilization of the results of the assessment. This document will: 1) Identify the geographical areas and types of weather modification research that can have the greatest impact on agricultural production and other renewable resources; 2) Provide background and guidance to NSF and other federal and state research managers on areas and types of weather modification research that can have the greatest impact on agricultural production and other renewable resources. This can apply to those with responsibilities in the discipline areas of weather modification, meteorology, agriculture and atmospheric sciences; 3) Provide information to state and federal public administrators (Office of Technical Assessment, OMB, etc.), legislators, courts and the general public that can assist them in making wise decisions and plans regarding applications of weather modification; 4) delineate the needs, required efforts, and methods for a longer term, continuing evaluation of the interrelations between weather modification and agriculture.

Section XIV

WATER SUPPLY AUGMENTATION AND CONSERVATION

USE OF WATER OF IMPAIRED QUALITY (GROUP 03C)

75:03C-001
TRICKLE IRRIGATION WITH WATER OF DIFFERENT SALINITY LEVELS,
Seifert, W.J. Jr., Hiler, E.A., Howell, T.A.
William F. Guyton & Associates, Austin, Texas.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 1, p 89-94, January-February 1975. 8 fig, 2 tab, 16 ref.

Descriptors: *Salinity, *Saline water, *Irrigation, *Irrigation effects, *Sorghum, Surface irrigation, Lysimeter, Leaching, Crop response.

Objectives of this study were (a) to determine effects of different concentrations of saline water on grain sorghum production and soil environment using trickle irrigation, and (b) to evaluate effects of irrigation water at one electrolyte concentration with both surface and trickle irrigation. The study was conducted in a sheltered lysimeter installation during two successive seasons. A Norwood silt loam soil was utilized in the lysimeters. Salts were purposely not leached between seasons so that salinity buildup effects could be evaluated. Numerous crop, soil and meteorological parameters were measured and evaluated to quantify effects of various treatments on the crop and soil.

75:03C-002
EFFECTS OF FREQUENCY OF SPRINKLING WITH SALINE WATERS COMPARED WITH DAILY DRIP IRRIGATION,
Bernstein, L., Francois, L.E.
Agricultural Research Service, Riverside California Salinity Lab.
Agronomy Journal, Vol. 67, No. 2, p 185-190, March-April, 1975. 2 fig, 6 tab, 13 ref.

Descriptors: *Sprinkler irrigation, *Crop production, *Plant physiology, *Irrigation water, Sprinkling, Saline water, Salts, Sodium chloride, Calcium chloride, Salt tolerance, Foliar, Leaves, Irrigation effects, Plant growth, Application methods.

Bell peppers (Capsicum frutescens) were sprinkled every 2.3, 3.5, and 4.75 days with low salt (450 mg/liters) and medium and high salt waters (1,000 and 2,000 mg/liter of added NaCl + CaCl2). Additional plots were drip irrigated with the same waters. Sprinkling with the low-salt water and drip irrigation with all 3 waters caused no leaf damage. Plants sprinkled every 2.3 days with the 2 high salt waters suffered more leaf burn and produced lower yields than plants sprinkled less often. Sprinkling with the high-salt water reduced yields more than 50% at all sprinkling frequencies. Injury and yield loss appear to be related primarily to foliar salt absorption.

75:03C-003
SALINITY-OZONE INTERACTIVE EFFECTS ON ALFALFA YIELD AND WATER RELATIONS,
Hoffman, G.J., Maas, E.V., Rawlins, S.L.
Agricultural Research Service, Riverside, California Salinity Lab.
Journal of Environmental Quality, Vol. 4, No. 3, p 326-331, July-September, 1975. 4 fig, 5 tab, 18 ref.

Descriptors: *Salinity, *Ozone, *Soil-water-plant relationships, *Alfalfa, Irrigation water, Saline water, *Crop production, Plant growth, Agriculture, Air pollution, Leaves.

The effect of ozone of forage yield of alfalfa (Medicago sativa L. cv. Moapa) was determined at four controlled salinity levels (NaCl and CaCl2) having osmotic potentials of -40, -200, -400, and -600 kilopascals. For nonsaline treatments, ozone greatly reduced yields when alfalfa was exposed to daily 2-hour periods of

10-20 parts per hundred million; concentrations that are prevalent in many agricultural areas. As salinity increased, ozone had less effect on yield, and a 25% greater yield was produced with salinity at moderate, but not detrimental levels. Salinity at all levels or ozone at 20 parts per hundred million increased water use efficiency of alfalfa, and low concentrations of ozone had no effect on water-use efficiency. Both ozone and salinity together were required to increase leaf diffusion resistance.

75:03C-004
RESPONSE TO THREE SEMIDWARF MEXICAN WHEATS TO DIFFERENT AERATION CONDITIONS IN THE ROOTING MEDIUM AT A CONSTANT SALINITY LEVEL,
Everardo, R.,   Stolzy, L.H., Mehuys, G.R.
Escuela Nacional de Agricultura Chapingo (Mexico).
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 515-518, May-June, 1975. 2 Fig, 2 tab, 13 ref.

Descriptors: *Soil gases, *Aeration, *Oxygen requirements, *Root zone, *Plant growth, *Wheat, Agriculture, Soil environment, Environmental control, Soil physical properties, Soil properties, Soil chemistry, *Soil-water-plant relationships, Soil physics, Dissolved oxygen, Oxygenation, Zone of aeration, Crop response, Plant physiology, Salinity, Root development, Mexico, Transpiration.

The response of 3 newly developed Mexican wheat (Triticum aestivum L.) varieties, Nuri 70, Inia 66, and Siete Cerros 66, to low oxygen at constant salinity of -4 bars in the rooting medium was tested in a water culture experiment under growth chamber conditions. Oxygen concentrations in solution were maintained at 1.5, 5.2, and 7.6 ppm. All varieties were affected by low oxygen at high salinity but Inia 66 had the greatest adaptability. Oxygen concentrations of 1.5 ppm decreased plant dry-matter production by 50% and reduced transpiration by 54-65%. Root porosities increased with each decrease in oxygen content, with Inia 66 showing the largest increase. A 5.2 ppm oxygen concentration in solution was found to be optimum for grain yield, water use, and leaf and root dry matter production if Inia wheat was grown without salinity stress in the root zone.

75:03C-005
MODEL OF SOIL SALINITY EFFECTS ON CROP GROWTH,
Childs, S.W., Hanks, R.J.
Utah State University, Logan. Department of Soil Science and Biometeorology.
Soil Science Society of America Proceedings, Vol. 39, No. 4, p 617-622, July-August 1975. 9 Fig, 2 tab, 12 ref.

Descriptors: *Saline soils, *Crop response, *Mathematical models, Soil physical properties, Crop production, Osmotic pressure, Irrigation design, Irrigation efficiency, Irrigation systems, Salt balance, Water management(Applied), Drainage, Evapotranspiration, Root distribution, Water quality, Soil water movement, Soil moisture, On-site tests, Climatic data, Groundwater, Irrigation.

The model considered properties of the soil, water, plant, and atmospheric system to predict relative crop yield. Crop yield predictions assume a direct relation between dry matter production and transpiration. The only salinity effects considered were osmotic potential. The influence of initial soil salinity on crop growth depended upon the crop type and irrigation management. Predictions made of salt buildup over several years showed that some water management systems would produce high yields for several years before salt buildup would decrease yields. Predictions showed that the influence of irrigation system uniformity on salinity buildup and yield reduction is very important.

75:03C-006
USE OF GEOTHERMAL WATER FOR AGRICULTURE,
Bishop, A.A.
Utah State University.

Aerojet Nuclear Company, Idaho National Engineering Laboratory, Idaho Falls, Idaho. [illegible] No. 1231, June 1975. 10 fig, 1 tab, 30 ref. 56 pages.

Descriptors: *Geothermal studies, Agriculture, Irrigation, Water quality, Crop production.

The use of geothermal resources in agriculture will depend largely upon the site specific conditions of the resources. Both water and heat have many applications in agricultural production and the technologies for their use are generally known. When the quantity, quality, and the location of the geothermal water supply is known, the value of the water for irrigation can be readily estimated. The value for other uses such as for food and feed processing, space heating and cooling for crops and for animals is less readily determined. Application of geothermal water for irrigation purposes as well as other farm uses is extensively discussed. Advantages and disadvantages of the use of geothermal water for animal production are presented. An extensive set of references are included to aid the reader in gaining additional insight into the water quantity and quality requirements for agricultural applications.

75:03C-007
SOIL WATER EXTRACTION BY ALFALFA.
Brun, L.J., Worcester, B.K.
North Dakota State University, Fargo, Dept. of Soils.
Agronomy Journal, Vol. 67, No. 4, p 586-589, July-August 1975. 1 fig, 2 tab, 9 ref.

Descriptors: *Saline soils, *Salinity, *Alfalfa, Crop response, Crop production, Soil water, Moisture tension, North Dakota, Montana.

Saline seeps have developed because of the accumulation of water beyond the rooting zone of annual crops. The purpose of this experiment was to show the potential of alfalfa to extract soil water under a variety of textural and salinity conditions. Core samples were taken in alfalfa fields and fields under crop-fallow management to evaluate their present water content, 15 atm. percentage, texture, and salinity level. Significant extraction of soil water occurs to depths of 3 to 4 m. Alfalfa extracted soil water held at a tension greater than 15 atm. in both saline and non-saline segments of the soil profile. A minimum soil moisture level was reached at the 1.22 to 2.44 m depth in alfalfa fields maintained 5 years. Alfalfa is an invaluable crop for reducing soil wetness to alleviate the saline-seep problems of western North Dakota and eastern Montana.

75:03C-008
INFLUENCE OF SALINITY AND N-P FERTILITY LEVELS ON MINERAL CONTENT AND GROWTH OF SORGHUM IN SAND CULTURE.
Patel, P.M., Wallace, A., Wallihan, E.F.
California University, Riverside, CA.
Agronomy Journal, Vol. 67, No. 5, p 622-625, September-October 1975. 1 fig, 1 tab, 19 ref.

Descriptors: *Grain sorghum, *Soil salinity, *Salinity, *Crop response, Irrigation, Irrigation effects, Crop production, Agriculture, Salt tolerance, Fertilizer, Fertilization, Nitrogen.

Plant growth is characteristically depressed at certain levels of salt concentrations yet it sometimes responds to fertilizers even though growth depression can be expected to reduce nutrient requirements and even though fertilizer application increases salinity to some degree. This study was designed to examine tension zones involving interactions between nutrient supply (N and P) and salt concentrations. Grain sorghum was chosen for this study because it is commonly grown in regions of irrigated agriculture where soil salinity is often a problem. Plants were grown to maturity in automatically operated sand culture equipment at two levels each of N and P, each subjected to added Ca-Na chloride salinity levels of zero, medium (EC=10 MMho/cm) and high (EC=20 mmho/cm). Vegetative growth was depressed to about 50% of control at both medium and high salinity, while grain production was depressed to about 15% at medium salinity and to almost none at high salinity.

75:03C-009
SALINITY EFFECTS ON RICE AFTER THE BOOT STAGE.
Kaddah, M.T.; Lehman, W.F.; Meek, B.D.; Robinson, F.E.
Imperial Valley Conserv. Res. Center, Brawley, CA.
Agronomy Journal, Vol. 67, No. 3, p 436-439, May-June 1975. 1 fig, 1 tab, 17 ref.

Descriptors: *Rice, *Salinity, *Crop response, *Salt tolerance, Flood irrigation, Crop production.

Effect of salinity on rice after the boot stage has been controversial in the literature. Some authors maintain that rice is sensitive to salt at flowering, whereas others have found no evidence to support these views. The present greenhouse study evaluates the interaction after the boot stage of salinity, soil texture, and rate of drainage on rice development.

WATER SUPPLY AUGMENTATION AND CONSERVATION

CONSERVATION IN AGRICULTURE (GROUP 03F)

75:03F-001
IRRIGATION RUNOFF RECOVERY IN THE DESIGN OF CONSTANT FURROW DISCHARGE IRRIGATION SYSTEMS,
Stringham, G.E., Hamad, S.N.
Utah State University, Logan. Department of Agricultural and Irrigation Engineering.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 1, p 79-84, January-February 1975. 3 fig, 2 tab, 4 ref.

Descriptors: *Irrigation, *Irrigation design, *Irrigation engineering, *Furrow irrigation, Irrigation systems, Agricultural engineering, Furrow systems, Runoff.

A method was presented to design an Irrigation Runoff Recovery System which will permit a constant furrow discharge throughout the irrigation set by irrigating the first set entirely from supply water, the last set entirely from pumped runoff water, and by varying the set size between the two. Since the system requires a variable number of furrows from set to set, a table and charts were presented to give the number of furrows required in successive sets, number of sets required, number of furrows in the late set irrigated entirely from stored runoff, storage volume required, potential water savings, area covered by the storage pond, and recirculating-pump flow rate.

75:03F-002
ECONOMICS OF INCREASED MOBILITY FROM TILE DRAINAGE,
Aldabagh, A.S.Y., Beer, C.E.
Mosul University, Mosul, Iraq., College of Engineering.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 1, p 116-121, January-February 1975. 4 fig, 3 tab, 16 ref.

Descriptors: *Drainage, *Drainage engineering, *Drains, *Drainage systems, Economics, Economic impact.

The purpose of this study was to estimate the added economic benefit of tile drainage from increased mobility of agricultural machinery. This was achieved by first relating the performance of vehicles to soil strength in terms of rating cone index. The rating cone index was evaluated by the cone penetrometer and remolding equipment. Relations then were developed between soil strength, moisture content, and depth to water table for poorly drained soils. Existing data were used in predicting the behavior of water table for various drain spacings and soil conductivities. A tile depth of 4 ft, a tile diameter of 0.5 ft, and a depth to the impervious layer below the drain of 4 ft, were assumed. The results were applied to determine the increased number of days in which machine operations can be performed during the planting season when tile drains with various spacings are used.

75:03F-003
LIMITED IRRIGATION OF GRAIN SORGHUM IN ALTERNATING STRIPS WITH WHEAT,
Musick, J.T., Dusek, D.A.
United States Department of Agriculture, Southwestern Great Plains Research Center, Bushland, Texas.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 3, p 544-548, May-June 1975. 5 fig, 1 tab, 12 ref.

Descriptors: *Sorghum, *Wheat, Irrigation, Irrigation practices, Furrow irrigation, Surface irrigation, Irrigation effects, Crop response.

Grain sorghum and winter wheat are the two major irrigated crops in the Southern High Plains. In 1973, irrigated grain sorghum was grown on 863 200 ha and irriga-

and winter wheat on 486 000 ha (Kay 1973). Declining groundwater tables and well yields necessitate conservation and efficient use of limited irrigation water supplies. Management practices are needed for reducing water application in furrow irrigated systems. This paper reports results from the grain sorghum phase of a 3-year field study in which grain sorghum and winter wheat were grown in alternating 4.88-m wide drill strips.

75:03F-004
IRRIGATING CORN AND GRAIN SORGHUM WITH A DEFICIENT WATER SUPPLY,
Stewart, J.I.; Misra, R.D.; Pruitt, W.O.; Hagan, R.M.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 2, p 270-280, March-April 1975. 7 fig, 8 tab, 15 ref.

Descriptors: *Corn, *Sorghum, *Irrigation, *Irrigation effects, *Irrigation practices, Crop response, Evapotranspiration, Crop production.

Maximizing crop production with limited irrigation water requires quantitative information about differential yield responses to given levels of water deficit in each major growth period. The pollination period of corn is widely thought of as a "critical period" in this regard. Our findings support the idea that corn grain yield is especially vulnerable to water deficits during the pollination period, provided the crop has experienced little or no ET deficit in the late vegetative period, ending at first tassel. However, we find the susceptibility of corn yield to deficits in the pollination period to be greatly lessened if there have been prior deficits. This is expressed as a "conditioning" factor which is important to the planning of irrigation programs which, either by choice or by exigencies of water supply, include ET deficits during one or more major growth periods. Grain sorghum yield is found to be markedly less sensitive to ET deficits than corn, and there is no indication that a conditioning factor operates with this crop. The yield reduction ratios found for the two crops are summarized.

75:03F-005
IRRIGATION SYSTEM MANAGEMENT FOR REDUCING PEAK ELECTRICAL DEMANDS,
Stetson, L.E.; Watts, D.G.; Corey, F.C.; Nelson, I.D.
United States Department of Agriculture, Agricultural Research Service, Lincoln, NE.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 2, p 303-306, 311, March-April 1975. 3 fig, 1 tab, 9 ref.

Descriptors: *Electric Power, *Irrigation operation and management, Irrigation effects, Nebraska, Irrigation, Agriculture, Energy.

Peak summer power demand and the ratio of summer to winter loads limit electric energy for irrigation in Nebraska. An experiment conducted to schedule operation of irrigation systems during hours of lower electrical demand showed that peak summer demand loads can be reduced. The peak electrical demand of a power district was reduced, but crop yields were not. The scheduled irrigation systems used less total energy and water. Power districts and irrigators are expected to use results of this experiment either to increase the area irrigated or to reduce future energy and water demands.

75:03F-006
ANHYDROUS AMMONIA APPLICATION IN IRRIGATION WATER VERSUS MECHANICAL AND ITS EFFECT ON CORN YIELDS,
Mulliner, H.R.; Frank, K.D.
Nebraska University, Lincoln, Department of Agricultural Engineering
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 3, p 526-528, May-June 1975. 5 tab, 3 ref.

Descriptors: *Corn, *Crop response, *Irrigation water, *Irrigation, Fertilizers, Fertilization.

Furrow irrigators can make their systems perform double duty by putting fertilizer in the water. Anhydrous ammonia (NH3) can be applied along with the water, saving energy and the time consumed in conventional application. Anhydrous ammonia is not leachable in the ammonia form. Thus, high soil moisture conditions immediately after application present no problem. With soil temperatures above 50 F, ammonia is converted to the nitrate form. Nitrogen as nitrate is more available for plant use and becomes leachable if excess water penetrates through the soil profile. Injecting and applying NH3 through irrigation systems requires good water management. Presently it is not recommended for sprinkler systems due to the high volatilization loss of ammonia. The purpose of this experiment was to compare corn yields where the NH3 was applied in the surface irrigation water (gated pipe) to that of mechanical application (soil injected).

75:03F-007
NITROGEN CONSERVATION UNDER CORN PLANTED IN QUACKGRASS SOD,
Bennett, O.L., Stanford, G., Mathias, E.L., Lundberg, P.E.
United States Department of Agriculture, Agricultural Research Service,
Morgantown, WV
Journal of Environmental Quality, Vol. 4, No. 1, p 107-110, January-March 1975,
3 fig, 4 tab, 18 ref.

Descriptors: *Fertilization, *Fertilizers, *Grasses, *Nitrogen, Crop response, Corn.

The mechanics of growing corn in a grass sod using the no-tillage concept have recently been developed. However, little is known about the fate of fertilizers, especially nitrogen, or the potential uses of such plant species as quackgrass in this management system. Silage yields of corn were determined from field studies in which corn sod-planted in quackgrass, treated with six rates of atrazine, was compared to conventionally planted corn. The effects of no tillage and conventional tillage, using two rates of atrazine on total soil N, and N mineralization potential were compared. Yields of corn silage produced in herbicide-treated quackgrass were significantly higher than yields from conventional tillage. In the first year, silage yields increased with rates of atrazine. Quackgrass persisted for a 2-year period at the three lowest rates of atrazine but not at higher rates. After the first season, mineral N (largely NO(3)-N) was significantly greater under untilled quackgrass than under plowed plots. However, by the following spring, differences associated with tillage method had disappeared. Soil N mineralization potential, NO, and total N in the 0- to 15-cm layer were considerably higher for untilled than for plowed soils. However, in untilled plots, these values were unaffected by rate of atrazine.

75:03F-008
DEEP TILLAGE OF GRADED-FURROW-IRRIGATED PULLMAN CLAY LOAM,
Musick, J.T., Dusek, D.A.
United States Department of Agriculture, Southwestern Great Plains Research
Center, Bushland, TX.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 2,
p 263-269, March-April 1975. 9 fig, 3 tab, 14 ref.

Descriptors: *Soil environment, *Soil investigations, *Soil management, *Soil properties, Soil texture, Crop response, Surface irrigation, Irrigation, Furrow irrigation.

Pullman clay loam was deep tilled with a large moldboard plow to 40, 60, and 80 cm in 1966 at the USDA Southwestern Great Plains Research Center, Bushland, Texas. Deep tillage was compared with 20-cm normal tillage depth. The deep tillage treatments partially or completely penetrated slowly permeable clay Bt horizons that extended to about the 60-cm depth and partially mixed the clay Bt with the more permeable clay loam surface A horizon. The long-term effects were evaluated during the production of nine crops over a 7-yr period. The major effects on increasing water intake and yields under limited irrigation were obtained from increasing tillage depth from 20 to 40 cm. Increasing tillage depth to 60 and 90 cm, which completely penetrated the slowly permeable clay Bt horizon, had a smaller additional effect on water intake and little or no additional effect on yields.

75:03F-009
OPTIMIZING WATER UTILIZATION THROUGH MULTIPLE CROPS SCHEDULING,
Huang, W.; Liang, T.; Wu, I.
Hawaii University, Honolulu, Agricultural Engineering Department.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 2, p 293-298, March-April 1975. 5 fig, 2 tab, 19 ref.

Descriptors: *Model studies, *Water utilization, *Hawaii.

This study is divided into two parts. The first part deals with the construction of a mathematical model that will determine the cropping pattern for the efficient use of water. The second part applies the model to the Kalamilo area. Two case studies are presented. The difference between the two case studies is that the first allows less choice of planting time than the second one. The modeling work was carried out in the following steps: 1) Construction of a tentative operation schedule chart that will realistically relate the water demands to their supplies in short time periods. 2) The chart is then used as a basis for formulating constraints. Information obtained from the tentative operation schedule chart was used to formulate constraints and to identify the number of decision variables. A computer program was developed to translate the information obtained from the operation chart into proper MPS (mathematical programming system/360) input form.

75:03F-010
WHEAT YIELD MODELS WITH LIMITED SOIL WATER,
Neghassi, H.M.; Heermann, D.F.; Smika, D.E.
Colorado State University, Fort Collins, Colorado.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 3, p 549-553, 557, May-June 1975. 4 fig, 3 tab, 24 ref.

Descriptors: *Wheat, *Model studies, Soil water, Soil moisture, Crop response, Yield equations, Crop production.

Wheat dry matter yield was highly correlated to cumulative ET and cumulative daily relative ET. The linear models with approximate marginal productivities of 200 kg/ha/cm and 100 kg/ha/cmcm may be sufficient for predicting dry matter yields when soil water is limiting. The scaling of ET by corresponding daily ETO is believed to reconcile climatic differences. Further tests and comparisons are necessary to establish ranges for the coefficients and applicability of the scaling.

75:03F-011
2020 HINDSIGHT: ANOTHER FIFTY YEARS OF IRRIGATION,
Dreyfus, D.A.
Committee on Interior and Insular Affairs (U.S. Subcommittee on Water and Power Resources.
Journal of the Irrigation and Drainage Division, ASCE, Vol. 101, No. IR2, Proceedings paper No. 11363, p 87-94, June 1975. 4 ref.

Descriptors: *Irrigation, *Planning, *Water resources, *Water supply, Regional development, Reclamation, Agriculture, Management, Decision making, Water policy, Colorado River.

Water resources management has been a concern of governments from the time of the earliest recorded civilizations. In the United States, policies that have evolved over several decades to guide the Federal role in water resources planning and development are no longer relevant to national problems and goals. Water resources planning presently is in disarray because mechanical analysis has been substituted for continued policy guidance. The nation appears to be approaching a major reevaluation of governmental water resources policy. New objectives and a new

Federal role will be defined. Recent social and economic conditions indicate that there will be renewed national interest in the management of western water resources and that irrigated agriculture will continue to be a significant function in federal water policy.

75:03F-012
NO-TILL SEEDING OF IRRIGATED SORGHUM DOUBLE CROPPED AFTER WHEAT,
Allen, R.R.; Musick, J.T.; Wood, F.O.; Dusek, D.A.
United States Department of Agriculture, Bushland, TX. Southwestern Great Plains Research Center.
Transactions of the American Society of Agriculture Engineers, Vol. 18, No. 6, p 1109-1113, November-December 1975. 7 fig, 3 tab, 8 ref.

Descriptors: *Sorghum, *Till, Seed treatment, Irrigation, Wheat, Crop response, Agriculture, Crop production.

Irrigated grain sorghum was successfully no-till seeded into wheat residue immediately following wheat harvest in the Southern High Plains. Grain sorghum grown with clean tillage and seeding was grown for comparison. No-till seedlings generally emerged faster, grew taller, and matured up to 5 days earlier than controls. Grain yields for a 5-yr study averaged 5,680 kg/ha for no-till and 5,070 kg/ha for clean-till, a 12 percent increase. No-till required only one-fifth as much time between crops to prepare and plant a seedbed. No-till reduced fuel requirements, including harvest, by 55 percent.

75:03F-013
EROSION CONTROL WITH NO-TILL CROPPING PRACTICES,
McGregor, K.C.; Greer, J.D.; Gurley, G.E.
United States Department of Agriculture Sedimentation Laboratory, Oxford, MS.
Transactions of the American Society of Agricultural Engineers, Vol. 18 No. 5, p 918-920, September-October 1975. 3 fig, 1 tab, 9 ref.

Descriptors: *Erosion, *Erosion control, *Till, Crop Production.

No-till cropping systems (continuous soybeans, soybean-corn rotation, and soybeans double-cropped with wheat) were very effective in reducing erosion. Soil loss from conventional-till soybeans was significantly higher than that from any of the no-till systems. No significant differences in soil loss were greater during storms with excessive rate rainfall.

75:03F-014
CROP RESPONSE TO CHISELING AND IRRIGATION IN SOILS WITH A COMPACT A2 HORIZON,
Doty, C.W.; Campbell, R.B.; Reicosky, D.C.
Coastal Plains Soil and Water Conservation Research Center, Southern Region.
Transactions of the American Society of Agricultural Engineers, Vol. 18 No. 4, p 668-672, July-August 1975. 7 fig, 4 tab, 14 ref.

Descriptors: *Crop response, *Chiseling, *Irrigation, *Irrigation effects, Crop production, Corn, Furrow irrigation.

The objective of this study was to determine the yield of millet and sweet corn under four soil-water management regimes and to evaluate yield differences in terms of oxygen stress, depth of rooting, and soil water status in a coarse-textured soil with a compact A2 horizon. The experiment was conducted on a Varina sandy loam soil with a slope of less than 1 percent. Millet was grown as a test crop in 1969 and 1970 and primary tillage treatments as main plots, with and without furrow irrigation.

75:03F-015
OPTIMIZATION OF WATER USE EFFICIENCY UNDER HIGH FREQUENCY IRRIGATION II. SYSTEM SIMULATION AND DYNAMIC PROGRAMMING,

Howell, T.A., Hiler, E.A., Reddell, D.L.
New Mexico State University, Las Cruces. Agricultural Engineering Department.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 5,
p 879-887, September-October 1975. 3 fig, 5 tab, 18 ref.

Descriptors: *Model studies, *Simulation analysis, *Irrigation efficiency, *Irrigation practices, Irrigation design, Irrigation, Soil moisture.

An environmental simulation model (temperature, rainfall, and potential evaporation) was developed for Temple, Texas. The model was similar to that developed by Jones et al. (1972) for State College, Mississippi. Using Monte Carlo techniques, these daily environmental data could be simulated for input to the soil water balance model. The simulation results adequately represented the stochastic serial-correlation of these variables. The soil water balance model was modified to allow for root zone extension, runoff calculations, and grain sorghum leaf area index simulation (Ritchie and Arkin 1973). The model can separately calculate the plant and soil evaporation components. The root zone was assumed to linearly expand from 150 mm at germination to 1750 mm at the rate of 12 mm/day. Runoff was computed by the SCS equation.

75:03F-016
POWER FACTORS AND ELECTRICAL DEMANDS OF CENTER-PIVOT IRRIGATION MACHINES,
Stetson, L.E., Nelson, S.O.
United States Department of Agriculture, Agricultural Research Service, North Central Region.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 4,
p 673-676, July-August, 1975. 4 fig, 2 tab, 3 ref.

Descriptors: *Irrigation effects, *Electric power demand, *Electric power costs, Irrigation practices, Irrigation, Irrigation system.

Some operating characteristics of electrically driven, center-pivot irrigation machines were measured in the field. Peak power demands over fractional-minute periods were about twice the average demand. Power factors for the machines ranged between 0.3 and 0.5, and at least 1 kVA per connected hp was necessary to meet average electrical demands. Higher average power was required for faster rates of travel, but peak power demand was independent of travel rate. Power required for movement of machines around drops in drive-motor circuits did not exceed the tolerance limits for the 460-V motors and controllers.

75:03F-017
POTENTIALLY BENEFICIAL USES OF SULFURIC ACID IN SOUTHWESTERN AGRICULTURE,
Miyamoto, S., Ryan, J., Stroehlein, J.L.
Arizona University, Tucson, Arizona Agricultural Experiment Station.
Journal of Environmental Quality, Vol. 4, No. 4, p 431-437, October-December 1975.
63 ref.

Descriptors: *Acids, Waste disposal, Land reclamation, Sodium.

Production of sulfuric acid is projected to exceed market demand in the southwestern USA if current air pollution control regulations are fully implemented by means of acid plants. Considerable quantities of surplus acid can be used beneficially for reclaiming sodium-affected calcareous soils, increasing the availability of phosphorus and certain micronutrients, treating alkaline and ammoniated irrigation water, controlling certain weeds and soil-borne pathogens, improving range grass establishment and growth, and for several other purposes. Principles involved in these uses are reasonably well established, but studies are required to determine effective use especially in the area of field application.

75:03F-018
LEACHING LOSSES OF AMMONIUM AND NITRATE IN THE RECLAMATION OF SAND SPOILS IN CORNWALL,
Dancer, W.S.
Liverpool University, Liverpool, England. Botany Department.

Journal of Environmental Quality, Vol. 4, No. 4, p 499-504, October-December 1975. 4 fig, 3 tab, 15 ref.

Descriptors: *Leaching, *Ammonium compounds, *Ammonium salts, Fertilizers, Fertilization, Nitrate, Land reclamation, Nitrogen.

Reclamation studies on sand spoils in Cornwall have shown a difficulty in maintaining adequate levels of nitrogen for plant growth. Information is presented to show that the movement of NO3(-) and NH4(+) is highly correlated with rainfall (r=0.95 and 0.92, respectively). Nitrate leaching is more serious than NH4 leaching and calculations show that more than 50% of the NO3(-) fertilizer applied to bare sand spoil will be leached beyond the surface 30 cm with an average month of summer rainfall (8.7 cm). Maximum inorganic-N fertilizer recoveries of 40 kg/ha are predicted for grass swards established on spoils flattened by earth-moving equipment, while recoveries < 20 kg N/ha are likely on steeply sloping sand heaps.

75:03F-019
STEADY INFILTRATION FROM BURIED, SURFACE, AND PERCHED POINT AND LINE SOURCES IN HETEROGENEOUS SOILS: II. FLOW DETAILS AND DISCUSSION,
Philip, J.R., Forrester, R.I.
Division of Environmental Mechanics, P.O. Box 821, Canberra City, A.C.T., 2601, Australia.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 408-414, May-June 1975. 10 fig, 19 equ, 7 ref.

Descriptors: *Soil water, *Soil water movement, *Subsurface irrigation, Furrow irrigation, Irrigation systems, Soil physical properties.

Part I (Philip, 1972) developed physically relevant source solutions of the quasi-linearized steady infiltration equation, generalized to apply to heterogeneous soils with conductivity depending exponentially on both moisture potential and depth. This paper discussed the results in further detail, and includes graphs of a wide range of solutions.

75:03F-020
ENERGY INPUTS TO IRRIGATION,
Batty, J.C., Hamad, S.N., Keller, J.
Utah State University, Logan. Department of Mechanical Engineering; and Utah State University, Logan. Department of Manufacturing Engineering.
Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers, Vol. 101, No. IR4, Proceedings paper 11810, p 293-307, December 1975. 13 fig, 5 tab, 3 equ, 15 ref.

Descriptors: *Energy, *Irrigation, *Irrigation systems, Land use, Operations, Water utilization, Efficiencies, Agriculture, United States, Installation, Pumping, Irrigation water costs, Water demand.

Energy inputs to irrigation are dramatically increasing as irrigated agriculture expands to meet world food demands and more sophisticated technologies are developed to increase water use efficiency. In this study, nine irrigation systems, designed for a specific land area, are analyzed, and the total energy inputs computed for each system. The analysis includes energy inputs to manufactured components and installation as well as operation and maintenance. The expected life of each system and the energy value of salvable materials are also taken into account. It is concluded that a practical balance must be established between maximizing water use efficiency and minimizing water use efficiency and minimizing energy inputs to the irrigation system. The installation energy requirements are by no means negligible compared to the energy requirements for pumping. Where water is in short supply or is only available at a high energy cost, the energy conservation associated with high water use efficiency in any type of system may outweigh all other energy inputs.

75:03F-021
SEDIMENT FROM DRAINAGE SYSTEMS FOR A HEAVY SOIL,
Schwab, G.O.; Nolte, B.H.; Brehm, R.D.
Ohio State University, Columbus, Ohio, Department of Agricultural Engineering.
Presented at the 1975 Winter Meeting of the American Society of Agricultural
Engineers, December 15-18, 1975, Chicago, Illinois. 7 p, 3 fig, 3 tab, 10 ref.

Descriptors: *Sediment discharge, *Sediment load, *Sediment transport, *Sediment yield, *Drainage, Drainage practices, Drainage systems, Drains.

Sediment losses from tile and surface drainage systems in a lakebed soil in northern Ohio were measured for 5 years (1968-72). Average annual losses were [illegible] kg/ha from tile only and [illegible] kg/ha for surface only. Expected losses for the combination tile and surface drainage system were [illegible] kg/ha. Losses ranged from about [illegible] to 5000 annually. Average net losses from sprinkler irrigation were negligible and usually more sediment was added than removed in the drainage water. Sediment concentration in tile flow from irrigation increased significantly with the antecedent soil moisture content. Concentrations were high at the beginning of flow but decreased to a nearly constant level after 20 hours. A possible explanation for the high concentrations is that the sediment moved in suspension with the water and not through the soil cracks. The total estimated soil loss from the surface drained only plots was within one percent of the measured losses. The estimated losses were computed from the universal soil loss equation. For the no-till plots the estimated losses were 16 percent higher than the measured whereas conventional tillage losses were 11 percent lower. A linear regression was significant at the 99% level. Estimates using a runoff factor rather than the rainfall factor in the soil loss equation were 81 percent of the measured values compared to 89 percent using the rainfall factor.

75:03F-022
IRRIGATION SCHEDULING AND SUGARBEET PRODUCTION,
Jardine, G.D.; Fox, R.D.
Agricultural Research, Northern Ohio Sugar Company, Fremont, Ohio 43420.
Presented at the 1975 Winter Meeting of the American Society of Agricultural
Engineers, December 15-18, 1975, Chicago, Illinois. 6 p, 4 tab, 6 ref.

Descriptors: *Sugarbeets, Irrigation, Irrigation practices, Crop response, Colorado, Soil moisture, Irrigation efficiency, Scheduling.

This paper centers on irrigation scheduling and sugarbeet production. The emphasis is upon the results of Great Western Sugar Company's irrigation studies and the recommendations for a successful sugarbeet irrigation program. Recommendations are: 1) begin the season with a full or nearly full soil moisture profile; 2) give the crop a boost with light irrigations for emergence and after thinning, if necessary; 3) schedule irrigations throughout the season using climate, crop, and soil data. Include also, the irrigators experience and habits where possible in determining the actual schedule; and 4) utilize irrigation scheduling to determine the cut-off dates for late season irrigations. These recommendations all point toward managing the soil moisture so the maximum sugar production can be attained by utilizing all the resources available to the grower. Today's sugarbeet grower must be a good manager. All tools researchers can provide to better manage irrigations will help insure the continued production of high yielding, high quality sugarbeets.

75:03F-023
TRICKLE AND SPRINKLER IRRIGATION OF GRAIN SORGHUM,
Ravelo, C.J.; Hiler, E.A.; Howell, T.A.
Texas A & M University, College Station, Texas 77843.
Presented at the 1975 Winter Meeting of the American Society of the Agricultural
Engineers, December 15-18, 1975, Chicago, Illinois. 17 p, 5 fig, 3 tab, 15 ref.

Descriptors: *Crop response, *Sorghum, *Irrigation practices, *Irrigation effects, *Sprinkler irrigation, Irrigation systems.

The crop response and water use efficiency (ratio of weight of grain harvested to centimeters of total crop water use) of grain sorghum was investigated using trickle and sprinkler irrigation. Also the effects of different trickle irrigation frequencies on the crop growth and ultimate grain yield were studied. Two different experimental investigations are reported in this paper, one conducted in 1973 and another in 1974. The 1973 sprinkler vs. trickle experiment had the following two irrigation treatments with three replications each: 1) trickle irrigated three times per week, and 2) overhead sprinkler irrigated three times per week. The irrigation amounts in each treatment were 1.1 times soil water losses as measured by the neutron method with gravimetric sampling in the upper 10 cm. The 1974 trickle irrigation frequency experiment had the following three treatments with three replications each: 1) trickle irrigated thrice weekly, 2) trickle irrigated twice weekly, and 3) trickle irrigated once weekly. From the results of these experimental investigations and for the given conditions of this study, the following conclusions can be drawn: 1) there were no significant differences in yield or water use efficiency when using trickle and sprinkler irrigation with a thrice-weekly frequency; and 2) different trickle irrigation frequencies (once, twice, and thrice weekly) with the same overall application amounts had no significant effect on grain sorghum yield or water use efficiency.

75:03F-024
SPRINKLER EVAPORATION LOSSES IN THE SOUTHERN PLAINS,
Clark, R.N.; Finley, W.W.
United States Department of Agriculture, Agricultural Research Service, Southwestern Great Plains Research Center, Bushland, Texas.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, December 15-18, 1975, Chicago, Illinois. 11 p, 5 fig, 8 ref.

Descriptors: *Sprinkler irrigation, *Evaporation, *Irrigation, *Irrigation effects, Water conservation, Wind velocity.

Water discharged from irrigation sprinklers was caught in specially designed containers in order to determine evaporation losses during sprinkling. Two nozzle sizes and three water pressures were tested during the study period. When the average wind velocity was less than 4.5 m/s (10 mph), the evaporation losses were generally less than 10% and the vapor pressure deficit had the greatest influence on the amount of evaporation. When average wind velocities were between 4.5 m/s and 9.5 m/s, losses increased exponentially with wind velocity. The wind velocity was the predominate factor under these conditions and evaporation losses ranged from 10 to 30%. Since much of the Southern Plains has an annual average wind velocity greater than 6 m/s, average evaporation losses can be expected to exceed 15%.

75:03F-025
SPRINKLER IRRIGATION PERCOLATION LOSSES,
Dylla, A.S.; Shull, H.
United States Department of Agriculture, Agricultural Research Service, Morris, Minnesota 56267.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, December 15-18, 1975, Chicago, Illinois. 8 p, 1 tab, 3 equ, 6 ref.

Descriptors: *Sprinkler irrigation, *Percolation, *Percolating water, Irrigation, Soil water, Soil water movement, Irrigation effects, Uniformity coefficient.

A workable procedure is presented for estimating sprinkler irrigation percolation losses. The method is based on the amount of water applied, the soil moisture deficit, and the sprinkler distribution uniformity coefficient.

75:03F-026
MEETING FUTURE WATER REQUIREMENTS BY WATER CONSERVATION,
Hedlund, J.D.
Soil Conservation Service, Golden, Colorado.

Presented at the 1975 Winter Meeting of the American Society of Agricultural
Engineers, December 15-18, 1975, Chicago, Illinois. 9 p, 2 fig, 3 tab.

Descriptors: *Water conservation, Irrigation, Irrigation practices, Water demand, Water utilization, Irrigation efficiency, Irrigation water, Water quality, Return flow, Water supply.

Applying best management practices available to irrigation could (1) reduce 1975 withdrawals of 195 million acre-feet by 48 million acre-feet, (2) salvage 8 million acre-feet of incidental losses, (3) reduce pollutant-laden return flow by 47 million acre-feet and (4) meet year 2000 production demands.

75:03F-027
FACTORS INFLUENCING THE LOSS OF NITROGEN AND PHOSPHORUS FROM A TRACT OF IRRIGATED LAND,
Busch, J.R., Fitzsimmons, D.W., Lewis, G.C., Naylor, D.V., Yoo, K.H.
Agricultural Engineering, University of Idaho, Moscow, Idaho.
Presented at the 1975 Winter Meeting of the American Society of Agricultural
Engineers, December 15-18, 1975, Chicago, Illinois. 11 p, 3 fig, 4 tab, 11 ref.

Descriptors: *Nitrogen, *Phosphorus, *Irrigation effects, Surface irrigation, Irrigation, Irrigation practices, Leaching, Nutrients, Return flow, Water pollution.

A study was conducted to identify factors that influence the loss of nitrogen and phosphorus from a tract of irrigated land. A multiple regression analysis was used to determine the influences of nine identifiable factors. The statistics of the analytical relationships obtained indicate that they are suitable for estimating the amounts of nutrients lost in surface runoff from the studied tract. The amounts of chemical constituents lost in surface runoff from a gravity irrigated farm are dependent upon several independent variables including total solids lost, amounts of nutrients applied, and water retained on the field. Specific conclusions drawn from the study area are: 1) The amounts of nutrients in the surface runoff were significantly affected by the amounts of total solids and water lost in surface runoff, and the amounts of nutrients applied in headwaters. 2) More soluble and total phosphorus and ammonia nitrogen were lost to surface runoff in earlier irrigations than in later irrigations. 3) Increasing the percentage of applied water retained on a field and reducing the amounts of fertilizer added to irrigation water would decrease the amounts of all nitrogen forms lost in surface runoff. All results presented are applicable to the study site monitored. However, the relationships developed and conclusions drawn may be applied with caution to similar areas managed with similar cultural practices.

75:03F-028
ESTABLISHING WATER, NUTRIENT AND TOTAL SOLIDS MASS BUDGETS FOR A GRAVITY-IRRIGATED FARM,
Fitzsimmons, D.W., Busch, J.R., Lewis, G.C., Naylor, D.V., Carlson, R.D.
Agricultural Engineering, University of Idaho, Moscow, Idaho.
Presented at the 1975 Winter Meeting of the American Society of Agricultural
Engineers, December 15-18, 1975, Chicago, Illinois. 15 p, 3 fig, 5 tab, 4 equ,
5 ref.

Descriptors: *Irrigation, *Irrigation practices, Furrow irrigation, *Surface irrigation, Evapotranspiration, Nutrients, Leaching, Return flow, Water pollution.

Mass budgets were established for a surface-irrigated farm and used to determine net losses of water, nutrients and solids from the farm. Data for establishing the budgets were obtained by monitoring surface flows and groundwater during two irrigation seasons. Flow and chemical analysis data were combined, using a computer model, to obtain the budgets.

75:03F-029
IRRIGATION REUSE SYSTEMS--A PROPOSED NEW ASAE ENGINEERING PRACTICE,

Hart, W.E.
Department of Agricultural Engineering, Colorado State University, Fort Collins, Colorado 80523.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, December 15-18, 1975, Chicago, Illinois. 24 p, 4 fig, 1 tab, 10 ref.

Descriptors: *Irrigation Systems, *Irrigation practices, *Irrigation design, *Irrigation engineering, Irrigation water, Irrigation, Agriculture, Furrow irrigation, Surface irrigation.

A subcommittee of the Surface Irrigation Technical Committee (SW-242) has prepared a draft document which will be submitted for consideration as an ASAE Engineering Practice. This document, which is reproduced here, has six sections--purpose and scope, definitions, system analysis, determination of runoff, system design, and costs. Reader comments are solicited.

75:03F-030
TILLAGE, MATRIC POTENTIAL, OXYGEN AND MILLET YIELD RELATIONSHIPS IN A LAYERED SOIL,
Campbell, R.B., Phene, C.J.
Coastal Plains Soil and Water Conservation Research Center, Florence, South Carolina.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, December 15-18, 1975, Chicago, Illinois. 17 p, 6 fig, 17 ref.

Descriptors: *Oxygen, *Crop response, *Soil tests, *Soil investigations, *Soil environment, Soil horizons, Soil moisture.

A unique relationship was established between soil O_2 content and soil water matric potential from which the O_2 content may be estimated from soil matric potential data. Yield of millet was a function of soil O_2 content from 2 to approximately 15%. At soil O_2 levels greater than 15%, the growth of millet was independent of soilO_2 content. Harvesting millet twice during the growing season which included a 14-day wet period produced significantly greater yields than harvesting three times. Chiseling the soil 35 cm deep one year before the experiment resulted in yields greater than those of the plowed soil, when the soil was in a wet condition, simulating a stormy 14-day period. Under a moderate soil water regime, in which the soil matric potential did not exceed -400 mb, aeration was adequate and the yield of millet was unaffected by tillage depth. Under high matric potential conditions, -45 to -67 mb, chiseling was beneficial as a means of partially alleviating soil oxygen stresses associated with a wet soil condition.

75:03F-031
AN EXPERIMENTAL BURIED MULTISET IRRIGATION SYSTEM,
Worstell, R.V.
United States Department of Agriculture, Agricultural Research Service, Snake River Conservation Research Center, Kimberly, Idaho.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, December 15-18, 1975, Chicago, Illinois. 15 p, 6 fig, 2 tab, 7 ref.

Descriptors: *Irrigation, *Irrigation systems, Irrigation design, Irrigation effects, Irrigation efficiency, Irrigation practices, Water conservation, Soil moisture, Soil moisture movement.

Criteria for the design, construction, and operation of an experimental buried lateral, gravity multiset irrigation system are presented. The system has a potential water application efficiency of 80% with very little runoff or erosion without automatic controls. With automatic controls and with water available on demand, light, frequent irrigations can be applied with efficiencies of 90 to 95%. The energy required to operate the system is minimal and labor requirements involve only periodic inspection and maintenance services. Cost and benefit estimates indicate that this system may be economically feasible, practical, and attractive at a time of rising energy costs and labor shortages.

75:03F-032
IMPROVEMENT OF WATER APPLICATION OF SELF-PROPELLED SPRINKLER IRRIGATION SYSTEMS,
Barefoot, A.D.
Oklahoma State University, Stillwater. Department of Agricultural Engineering.
Available from the National Technical Information Service, Springfield, VA 22161
as PB-245 762, $3.25 in paper copy, $2.25 in microfiche. Completion Report (1975).
17 p, 3 fig, 7 tab, 10 ref.

Descriptors: *Irrigation systems, *Sprinkler irrigation, *Uniformity coefficient, Trafficability, *Evapotranspiration, Evaporation, Winds, Root zone, *Oklahoma.

The number of center-pivot sprinkler irrigation systems is increasing in the central Great Plains. The reasons for this increase are their labor-saving advantages and versatility. The system's ability to irrigate rolling terrain with a wide range of application depths accounts for its versatility. The objectives of this project were to evaluate the depth and uniformity of application of a center-pivot system and to determine the depth of water stored in the crop root zone, evaporation losses and trafficability problems of a typical system during field conditions. Data were collected from a 1300 foot, electrically driven system. Both size and spacing of the nozzle heads are varied to obtain desired application rates on this system. The soil type was sand and the crop was peanuts. The average coefficient of uniformity was 85.2 with a standard deviation of 2.45. The uniformity appeared to decrease linearly with wind speed for the range tested. The average evaporation loss was 17.5 percent with 20.4 percent occurring during daytime irrigations and 10.8 percent at night. No trafficability problems were encountered on the sandy soil. Five systems were tested in the Oklahoma Panhandle. The systems varied in both design and lengths. Three of the systems were electrically powered and two were water driven. The average coefficient of uniformity for the five systems was 81.7. Only minor traction problems were observed in the clay loam or loam soils.

75:03F-033
TWO-DIMENSIONAL SOLUTES TRANSFER DURING NONSTEADY INFILTRATION: LABORATORY TEST OF MATHEMATICAL MODEL,
Bresler, E., Russo, D.
Cornell University, Ithaca , New York.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 585-587, May-June 1975. 3 fig, 3 ref.

Descriptors: *Solutes, *Infiltration, Irrigation, Irrigation effects, Irrigation practices, Soil-water movement, Mathematical model.

The theory of two-dimensional transport of solutes during nonsteady infiltration from trickle sources, as developed previously, was compared with experimental results. A laboratory experiment was conducted under conditions similar to those assumed in the two-dimensional plane flow model. The agreement between theory and experiment as expressed by salt concentration distribution and location of wetting fronts, is generally good. This suggests that the theory is applicable to many situations similar to the conditions studied.

75:03F-034
VARIATIONS IN THE NATURAL ABUNDANCE OF N OF WHEAT PLANTS IN RELATION TO FERTILIZER NITROGEN APPLICATIONS,
Shearer, G., Legg, J.O.
Center for the Biology of Natural Systems, Washington University, St. Louis, MO. 63130.
Soil Science Society of America Proceedings, Vol. 39, No. 5, p 896-901, September-October 1975. 4 fig, 3 tab, 11 ref.

Descriptors: *Nitrogen, *Fertilization, *Fertilizers, *Wheat, Crop response.

Measurements were made by two laboratories of the per mill (15)N excess of winter wheat plants grown at five locations in Pennsylvania on experimental plots. The plots were fertilized with N at various rates. The results from both laboratories showed a consistent decline in per mill (15)N excess with increasing rates of N application. Such a decrease in per mill (15)N excess is consistent with increasing contributions of fertilizer N to the plants as the rate of application increased, given that fertilizer N has a lower 15N content than the soil N. The coefficients of regression of per mill (15)N excess of wheat on N application rate were always negative and usually significantly different from zero. The regression coefficients computed from the results of the two laboratories were not significantly different from each other in 12 of 16 experiments. There was, however, a systematic, unexplained difference in the results from the two laboratories. A regression of one set of data on the other resulted in a regression coefficient significantly different from one, the theoretically expected value.

75:03F-015
FINAL REPORT ON FERTILIZER MOVEMENT THROUGH SOIL RESULTING FROM RAINFALL,
Phung, H.T., Bartholic, J.F., Buchanan, D.W.
Institute of Food and Agricultural Sciences, Florida University,
Contract No. 3-15371, July 1975. 39 p, 15 fig, 4 tab, 1 equ, 24 ref.

Descriptors: *Nutrients, *Rainfall, Fertilizer, Leaching, Irrigation effects, Agriculture.

This study had a number of components in addition to the determination of nutrient loss from the orchard. Those additional components are discussed first in this report since they provide background information needed to better interpret the results on nutrient loss. These parts include, first, a characterization of the soil in the orchard. Second, since soil moisture measurement was an important component, a brief discussion of the method used for determining soil moisture is included. The third part is a very major section involving evaluation of the water balance components occurring in the grove during the time nutrient loss was being determined. Because of their importance, figures for evapotranspiration are given by short periods for all of 1973. The fourth component covers nutrient loss from the peach orchard. This study involved the determination of over a thousand determinations of elements in the water outflow during the year-long study. Thus, it was possible to characterize in detail not only the major elements being leached from the orchard, but also minor elements. In addition, following the application of fertilizer, nutrients in the soil were monitored with respect to time after fertilizer application. Thus, considerable additional sampling was involved in characterizing the nutrients at three different depths versus time after application.

75:03F-016
SCIENTIFIC IRRIGATION SCHEDULING FOR SALINITY CONTROL OF IRRIGATION RETURN FLOWS,
Jensen, M.E.
U.S. Department of Agriculture, Agricultural Research Service, Western Region,
Snake River Conservation Research Center, Kimberly, Idaho 83341.
Environmental Protection Technology Series, November 1975. 91 p, 5 fig, 4 tab, 21 equ, 97 ref, 1 append.

Descriptors: *Irrigation, *Irrigation efficiency, Return flow, Irrigated land, Leaching, Salinity, Management, *Scheduling.

A comprehensive review is presented of irrigation water management principles, factors to be considered in improving irrigation water management, leaching requirements, climatological approaches to irrigation scheduling, scope of irrigation scheduling in 1974, basic concepts of scheduling services, and probable effects of scientific irrigation scheduling on salinity of return flows. A definition of irrigation water management efficiency is presented to evaluate the annual volume of irrigation water used relative to the optimum amount needed for maximum annual crop production or income. The term considers the minimum, but essential water needed for both consumptive and nonconsumptive uses. The lack of significant changes in irrigation efficiency during the past several decades is discussed and attributed to problems associated with the management of a complex soil-crop-environment system, a lack of economic incentives to make improvements, and ineffective traditional approaches to improve irrigation scheduling. New proposed minimal leaching practices are discussed. The author concludes that substantial improvements in irrigation efficiencies can be made before the proposed minimal LF are reached on most western irrigated projects.

75:03F-017
USE OF AMENDMENTS TO REDUCE WATER REQUIREMENTS FOR STAND ESTABLISHMENT OF SMALL-SEEDED CROPS,
Dennis, R.E., Edmond, U.W., Robbins, C.W.
Arizona University, Tucson, Arizona.
Project Completion Report, 15 pages, August 1975. 16 ref.

Descriptors: Seeds, Water conservation, Sugarbeets, Alfalfa, Acids, Soil amendments.

Soil crusting after planting is a serious problem in stand establishment of small-seeded crops in the Southwest. When crusting occurs in a saline, warm, soil, stand establishment problems are especially severe. It is customary to use costly irrigation water to keep seedbed surfaces moist after planting to reduce soil crusting and to lower soil temperatures. Phosphoric acid (24% and 12%) and sulfuric acid (95%) were evaluated to determine their effectiveness in reducing soil crusting and reducing the amount of water required to obtain stands of sugarbeets, alfalfa, wheat and barley. Phosphoric acid, applied in 4-6 cm bands over the seed row at planting and before irrigation, reduced crusting and increased sugarbeet and alfalfa seedling emergence. Emerged seedlings from phosphoric acid treated plots were larger and one irrigation (10-15 ha cm/ha) was saved in stand establishment. Sulfuric acid applied in bands reduced soil crusting. Soluble salts in the seed zone resulting from band application of sulfuric acid killed or damaged seedlings. Sulfuric acid, when applied in irrigation water to saline-sodic soils, improved plant growth and water use efficiency.

75:03F-018
TRICKLE IRRIGATION DESIGN,
Karmeli, D., Keller, J.
Rain Bird Sprinkler Manufacturing Corporation, Glendora, California. 1975.
133 pages.

Descriptors: *Irrigation, *Irrigation systems, Irrigation practices, Irrigation efficiency, Crop response, Soil water movement, Hydraulics, Design.

This text provides a rather complete review of trickle irrigation with sufficient handbook material and instruction for system design. It has been written with the student engineer, research and adviser, as well as existing and potential users, in mind. To enhance its usefulness, this text is written with both metric and English units of measurement.

75:03F-019
ANNOTATED BIBLIOGRAPHY ON TRICKLE IRRIGATION,
Smith, S.W., Walker, W.R.
Colorado State University, Fort Collins, Colorado. Agricultural Engineering Department, Environmental Resources Center.
Information Series No. 16, June 1975. 61 p.

Descriptors: *Irrigation, *Irrigation effects, *Irrigation practices, *Irrigation design, *Irrigation efficiency, *Irrigation engineering, *Irrigation systems, Evapotranspiration, Fertilization, Crop response.

Trickle irrigation (or drip irrigation) is a relatively new approach to supplying agricultural crops with moisture where natural precipitation is inadequate. Research relating to trickle irrigation is being conducted throughout the world, including a significant effort in the United States. To date, the application of this irrigation method in Colorado has been considered feasible only in orchards or greenhouses. However, increased emphasis on improving irrigation water management capabilities for salinity control, revegetation of lands disturbed by mining activities, etc., necessitates further examination. This report presents a compilation of annotated references from approximately 33 sources of technical literature. Its purpose is to allow the reader to assess the existing knowledge and evaluate information relevant to the problems being encountered as well as indicating where further study is necessary.

75:03F-040
EPA AND AGRICULTURE: ESTABLISHING A PARTNERSHIP,
Train, R.E.
Environmental Protection Agency, Washington, D.C. 20460.
Journal of Soil and Water Conservation, Vol. 30, No. 1, p 11-15. January-February 1975.

Descriptors: *Agriculture, *Environmental control, *Environment, Pollution, Water quality.

Ecologists often note that nothing man does in a natural system is done in isolation. Pollutants often cross natural barriers or otherwise interact to exercise profound effects on the world environment. On the other hand, corrective action taken in one place may produce benefits in others as well. Fortunately, water pollution control and soil and water conservation require identical measures in most instances. The control of soil erosion, for example, though it cannot prevent the loss of some soluble compounds, does keep waterways free of sediments with their attached, insoluble pesticides and nutrients. And pollution control itself is a vital part of any water conservation project.

75:03F-041
ENVIRONMENTAL CONSIDERATIONS IN EXPANDING AGRICULTURAL PRODUCTION,
Crosson, P.R.
Latin American Program for Resources for the Future, Inc., 1755 Massachusetts Avenue, N.W., Washington, D.C. 20036.
Journal of Soil and Water Conservation, Vol. 30, No. 1, p 23-28. January-February 1975.

Descriptors: *Environment, *Environmental effects, Agriculture, Crop production, Grains, Soybeans.

The environmental impacts of increasing agricultural production in the U.S. will depend upon the magnitude of the increase and the kind of technology employed to bring it about. In each case the range of possibilities is so wide that well-grounded statements about likely outcomes are difficult. The great imponderable with respect to production is the growth of foreign demand. This has been the major element in the recent dramatic shifts in prices and production of U.S. agricultural commodities, particularly grains and soybeans. U.S. farmers could easily accommodate prospective increases in domestic demand at reasonable costs, probably with a diminishing land base and a set of conservation and other measures designed to control the environmental impacts of expanded production. When the scenario is broadened to include foreign demand, however, the outlook becomes less clear and the possibility of greatly increased pressures on the environment emerges.

75:03F-042
SULFURIC ACID FOR THE TREATMENT OF AMMONIATED IRRIGATION WATER: I. REDUCING AMMONIA VOLATILIZATION,
Miyamoto, S., Ryan, J., Stroehlein, J.L.
Arizona University, Tucson, 85721.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 544-548, May-June 1975. 4 fig, 7 tab, 14 equ, 11 ref.

Descriptors: *Irrigated water, *Ammonia, *Ammonification, Water quality, Fertilizers, Fertilization, Acids.

Effects of sulfuric acid applied to ammoniated irrigation waters on ammonia volatile losses are analyzed theoretically and evaluated by laboratory and field experiments. Volatile loss of ammonia from irrigation waters is directly related to the concentration of NH4OH. Sulfuric acid application reduces the concentration of NH4OH relative to the total N applied as anhydrous or aqua ammonia, principally by lowering pH. This consequently reduces ammonia volatile loss, e.g., by as much as 50% when acid is applied at rates equivalent to ammonia. The reduction of ammonia loss by sulfuric acid application through forming NH4SO4- is nil. Simultaneous application of acid and ammonia may serve as a practical means of controlling ammonia loss as well as disposing of large quantities of projected surplus acid without reducing pH of irrigation water.

75:03F-043
CONVENTIONAL AND CONTROLLED-RELEASE NITROGEN SOURCES FOR RICE,
Wells, B.R., Shockley, P.A.
Arkansas University, Rice Branch of the Agricultural Experiment Station, Stuttgart, Arkansas 72160.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 549-551, May-June 1975. 3 tab, 8 ref.

Descriptors: *Soils, *Fertilizer, *Fertilization, *Ureas, *Nitrogen, *Rice, Crop production, Crop response.

Tests were conducted for the years 1967-1972 with rice to compare various formulations of sulfur-coated urea (SCU) and iso-butylidene diurea, (I.B.D.U.) with urea and ammonium sulfate as nitrogen sources on both silt loam and clay soils. The N sources were applied either preplant or topdress at rates up to 235 kg/ha to drill-seeded rice which was flooded at approximately 4 weeks following seedling emergence. Grain yields, dry weight, and N uptake indicated that the controlled-release N sources could be used to regulate rate on N supply to the plant throughout the growing season. Growth of direct seeded rice was slowed considerably during the early part of the growing season due to the slow rate of N release but grain yields were not drastically altered. Grain yields on the silt loam soils following use of the controlled-release N fertilizers were consistently equal to those following use of urea or ammonium sulfate. On the clay soils under intermittent flooding, use of SCU resulted in increased yields as compared to urea applied preplant, and in one year resulted in increased yields as compared to urea applied in split topdress doses. Both SCU and I.B.D.U. were suitable N sources for rice growing under the water management systems employed in these studies.

75:03F-044
WIND, SPRINKLER PATTERNS, AND SYSTEM DESIGN,
Seginer, I., Kostrinsky, M.
Faculty of Agricultural Engineering, Technion, Haifa, Israel.
Journal of the Irrigation and Drainage Division, Vol. 101, No. IR4, p 251-264, December 1975. 8 fig, 1 tab, 3 equ, 6 ref.

Descriptors: *Sprinkler irrigation, *Wind velocity, *Irrigation, *Irrigation design, *Irrigation efficiency, *Distribution patterns.

This study includes: 1. Due to the fact that wind speed and solar radiation were not correlated in the data on which this study is based, it was possible to show that the wind speed was not directly contributing to the water loss during sprinkling. 2. A method of sprinkler patterns reconstruction was developed, which yielded representative interpolated patterns, as well as reliable extrapolated patterns for no-wind conditions. 3. It was theorized and demonstrated that when the centers-of-mass of consecutive distribution patterns are equidistant, the water distribution is likely to be the optimal that can be achieved under the major constraints of the system.

75:03F-045
RESPONSE OF TWO PEANUT CULTIVARS TO IRRIGATION AND KYLAR,
Gorbet, D.W., Rhoads, F.M.

Ag Research Center, Marianna, FL 32446.
Agronomy Journal, Vol. 67, No. 3, p 373-376, May-June 1975. 1 fig, 4 tab, 10 ref.

Descriptors: *Peanuts, Irrigation, Irrigation practices, Irrigation effects, Crop production, Crop response, Tensiometers.

With improved yields resulting from new cultivars and production practices, irrigation of peanuts is receiving increased attention. The objective of this study was to measure the response of two peanut cultivars to soil-water management in the plow layer and to the growth regulator Kylar. Tensiometers were utilized to schedule irrigations for treatments in which soil moisture tension in the plow layer (20 cm) was maintained below 1 bar. In one treatment, plant wilt at midday was used as an indicator for irrigation. A plant growth regulator, Kylar, was applied in some treatments to reduce vegetative development. Total pod production of both cultivars was increased with irrigation, especially in dry seasons.

75:03F-046
DIFFERENTIAL EFFECT OF BERMUDA AND BAHIAGRASSES ON SOIL CHEMICAL CHARACTERISTICS,
Tan, K.H.; Beaty, E.R.; McCreery, R.A.; Jones, J.B.
Georgia University, Athens, GA 30602. Dept. of Agronomy.
Agronomy Journal, Vol. 67, No. 3, p 407-411, May-June 1975. 5 fig, 2 tab, 20 ref.

Descriptors: *Grasses, *Forage grasses, *Forages, *Organic matter, Crop response, Soil properties, Soil chemistry, Nitrogen, Fertilization.

The use of bermudagrass and bahiagrass has attracted considerable research attention with respect to forage production. Little information is available on the influence of these grasses on soil properties and a direct comparison to effectively estimate the differential effect of bermudagrass and bahiagrass on major soil chemical properties following 4 years of clipping and N fertilizers treatments. A randomized split plot experiment was carried out in three replicates using a Montevallo soil planted with several bermudagrass and bahiagrass varieties, receiving annual application of 0, 224, and 672 kg N per ha from 1967 to 1970. In 1971 herbage and soil samples were collected for yield and chemical analysis. The results indicated the absence of differences in the effects of the grasses on soil pH, N, P, K, and Ca, but there were differences in organic matter contents.

75:03F-047
MINIMAL LEACHING WITH VARYING ROOT DEPTHS OF ALFALFA,
Bernstein, L.; Francois, L.E.; Clark, R.A.
Soil Science Society of America Proceedings, Vol. 39, No. 1, p 112-115 January-February 1975. 3 fig, 2 tab, 5 ref.

Descriptors: *Leaching, *Alfalfa, Salinity, Lysimeters, Return flow, Saline water, Crop response, Salt tolerance.

Alfalfa was grown in greenhouse lysimeters with soil depths of 60, 120, and 180 cm to determine whether rooting depth affected tolerance to the low leaching percentage of 0.25. Salinities of the drainage waters averaged about 6 mmho/cm water. Steady-state salinity profiles were maintained for 3 years. Yields with the more saline water averaged 23% less than those of the controls, in good agreement with previous findings, but were not significantly affected by lysimeter depth. Water requirements and uptake of chloride and sodium were only slightly affected by lysimeter depth. Water requirements and uptake of chloride and sodium were only slightly affected by lysimeter depth. Salinity profiles with maximum salinities of 26 mmho/cm in the soil water can, therefore, be compressed into as little as a 60-cm depth with no greater effects on yield or salt uptake by the crop than those obtained with salinity profiles extended over 120 or 180 cm.

75:03F-048
EFFECT OF DEW ON LEAF WATER POTENTIALS AND CROP RESISTANCES IN A PASPALUM PASTURE,
Kerr, J.P.; Beardsell, M.F.
D.S.I.R., Palmerston North, New Zealand.
Agronomy Journal, Vol. 67, No. 5, p 596-599. September-October 1975. 3 fig,

28 ref, 1 append.

Descriptors: *Dew, *Pastures, *Pasture management, Evapotranspiration, Agriculture, Crop response.

Opportunities for comparing the water status of crops when the presence or absence of dew is the main environmental variable are rare. This paper reports the results of such a comparison made on successive days on a paspalum pasture. Leaf water potentials were measured with a pressure chamber, and the energy balance method was used to determine evapotranspiration. Crop resistances were calculated from the micrometeorological data. The presence of dew halved the early morning crop resistances. The paspalum pasture did not appear to exercise stomatal control over evapotranspiration until most of the dew had evaporated.

75:03F-049

SOYBEAN YIELDS AND LANCE NEMATODE POPULATIONS AS AFFECTED BY SUBSOILING, FERTILITY, AND NEMATICIDE TREATMENTS,

Parker, M.B., Minton, N.A., Brooks, O.L., Perry, C.E.
Agricultural Research Service, U.S. Department of Agriculture, Tifton, GA
Agronomy Journal, Vol. 67, No. 5, p 663-666, September-October 1975. 1 fig, 3 tab, 13 ref.

Descriptors: *Soybeans, *Crop response, *Nematodes, Fertilization, Nematicides, Soil compaction, Crop production.

Soil compaction, nematode damage, and fertility problems occurring singly and in combination appear to be responsible for low yields of soybeans in some Coastal Plain soils. This study was designed to determine if these conditions could be corrected with certain fertility treatments, subsoiling, and a nematicide.

75:03F-050

RESPONSE CURVES OF VARIOUS TURFGRASSES TO APPLICATION OF SEVERAL CONTROLLED-RELEASE NITROGEN SOURCES,

Volk, G.M., Horn, G.C.
Florida University, Department of Soil Science.
Agronomy Journal, Vol. 67, No. 2, p 201-204, March-April 1975. 6 fig, 9 ref.

Descriptors: *Turf, *Turf grasses, *Nitrogen, *Fertilizers, Fertilization, Ureas, Crop response, Crop production.

Responses of turfgrasses to controlled-release N sources, especially the newer materials have not been adequately evaluated under field conditions. This study obtained N time-release curves as measured by clippings taken periodically after the initial response to readily available N such products contain had subsided. Materials were surface-applied once, or at widely spaced intervals, to six different turfgrasses. Three to 4-day growth clippings were taken periodically to assess current N uptake rate against that from a standard treatment consisting of a continuous, uniform, weekly application of NH_4NO_3.

75:03F-051

CORN YIELD AND NUTRIENT UPTAKE AS AFFECTED BY WATER-TABLE DEPTH AND SOIL SUBMERGENCE,

Chaudhary, T.N., Bhatnagar, V.K., Prihar, S.S.
Punjab Agricultural University, Ludhiana, India.
Agronomy Journal, Vol. 67, No. 6, p 745-749, November-December 1975. 4 fig, 4 tab, 16 ref.

Descriptors: *Water table, *Corn, *Nutrients, Irrigation, Drainage, Crop response, Fertilization.

Crops are affected by fluctuations in the water table by seasonal rainfall and soil submergence during growth. A better understanding of their response will help us to optimize drainage and irrigation. Response of irrigated corn to (i) four static water-table depths (60, 90, 120, and 150 cm) as affected by the growing-season rainfall and (ii) single or repeated submergence for 1 to 8 days was studied in 58-cm diam by 183-cm long metal barrels using silt loam soil during 1971 and 1972. Crop response to water-table depths varied with rainfall during growth. In a wet year, water table at the 120-cm depth gave the highest and that at the 60-cm depth the lowest yield. In a relatively dry year, yield was highest with water tables at 60 and 90-cm depths and decreased with deeper water tables. It is indicated that a water table at 120-cm depth is desirable for corn.

75:03F-052
PHOSPHORUS UPTAKE BY SOYBEANS AS INFLUENCED BY MOISTURE STRESS IN THE FERTILIZED ZONE,
Marais, J.N., Wiersma, D.
Fort Hare University, South Africa.
Agronomy Journal, Vol. 67, No. 6, p 777-781, November-December 1975. 5 fig, 14 ref.

Descriptors: *Soil moisture, *Phosphorus, *Soybeans, *Moisture stress, Irrigation, Irrigation effects, Crop response.

Reports on the effect of soil moisture stress on plant uptake of P have been conflicting. The effect of the dynamic variation in soil moisture on P uptake by soybeans was studied *in vivo*. A split-root technique with plants grown in 3 liter containers in the greenhouse was used whereby moisture stress was localized in the zone having the only source of P for the roots, while water and P-free nutrients were supplied through the other portion of the root system. The procedure minimized the effect of plant-water deficit.

75:03F-053
YIELD AND QUALITY OF CORN AND GRAIN SORGHUM GRAIN AND RESIDUES AS INFLUENCED BY N FERTILIZATION,
Perry, L.J.Jr., Olson, R.A.
Nebraska University, Lincoln.
Agronomy Journal, Vol. 67, No. 6, p 816-818, November-December 1975. 3 tab, 13 ref.

Descriptors: *Grain sorghum, *Crop response, *Corn, *Nitrogen, *Fertilizers, *Fertilization, Crop production.

Crop residues of grain sorghum and corn have attracted attention as an alternate economical forage resource for livestock utilization. There are little data available on agronomic production factors affecting yield and quality of crop residues. We evaluated the effect of rate and time of N fertilization on irrigated corn and grain sorghum grain and residue yields, grain N content, and forage quality of the residues.

75:03F-054
ADVECTION MODIFICATION OF THE PRIESTLEY AND TAYLOR EVAPOTRANSPIRATION FORMULA,
Jury, W.A., Tanner, C.B.
California University, Riverside CA 92502.
Agronomy Journal, Vol. 67, No. 6, p 840-842, November-December 1975. 2 fig, 7 ref.

Descriptors: *Advection, *Evapotranspiration, *Evaporation.

The empirical formula of Priestley and Taylor (1972) relating the evapotranspiration from a well-watered surface to the net radiation and a function of the air temperature is modified to include a saturation deficit term to account for high local advection. The model is tested on two seasons of daily evapotranspiration measurements over irrigated potatoes resulting in good agreement and a substantial improvement over the unmodified formula. Alfalfa measurements are also represented well by the model, but no better than by the Priestley-Taylor formula calibrated during a period of high advection.

75:03F-055

EFFECT OF IRRIGATION AND NITROGEN ON THE DRY MATTER AND CRUDE PROTEIN YIELDS OF 'PANGOLA' DIGITGRASS,

Byam, L., Gumbs, F.A.
West Indies University, St. Augustine, Trinidad. Dept. of Soil Science.
Agronomy Journal, Vol. 67, No. 3, p 365-369, May-June 1975. 6 tab, 14 ref.

Descriptors: *Grasses, *Forage grasses, Irrigation effects, Irrigation, Crop response, Crop production, Dry farming, Dry seasons, Fertilizers, Fertilization, Nitrogen.

In Trinidad, West Indies, a dairy industry is being developed on Piarco fine sand/fine sandy loam soil. The soil is physically and chemically poor. The cattle obtain most of their food supply by grazing 'Pangola' digitgrass. There is an urgent need to increase grass production on this soil type. Inadequate water supply in the dry season limits grass production. Previous fertiliser trials with Pangola digitgrass on this soil type have indicated that N fertiliser is likely to give better yield response than P, K, or Ca. This trial was therefore conducted to determine the irrigation-N management for wet and dry season production of Pangola digitgrass on this soil at adequate levels of P and K.

75:03F-056

NUTRIENT DILUTION-ANTAGONISM EFFECTS IN CORN AND SNAP BEANS IN RELATION TO RATE AND SOURCE OF APPLIED POTASSIUM,

Terman, G.L., Allen, S.E., Bradford, B.N.
Soil Science Society of America Proceedings, Vol. 39, No. 4, p 680-685, July-August 1975. 6 fig, 2 tab, 12 ref.

Descriptors: *Corn, *Beans, *Crop response, *Potassium, Nutrients, Fertilization, Crop production.

Greenhouse pot experiments were conducted to compare responses of corn and snap beans to 0 to 1,600 mg of K/pot as KNO3, KCl, and K2SO4 on K-deficient soils (3 kg of soil/pot). Marked responses were obtained to applied K, which were similar among sources, except for a toxic salt effect of 1,600 mg of K as KCl. Marked reciprocal K-N, K-P, K-Ca, and K-Mg relationships with yield response to rates of applied K were attributed to both dilution and ion antagonism.

75:03F-057

INCREASING WATER USE EFFICIENCY THROUGH IMPROVED ORIFICE DESIGN AND OPERATIONAL PROCEDURES FOR SUBIRRIGATION SYSTEMS,

Wilke, O.C., Hiler, E.A.
Texas Water Resources Institute, Texas A & M University, Lubbock, Texas.
Technical Report No. 63, 1975. 37 p, 10 fig, 1 tab, 12 ref.

Descriptors: *Irrigation, *Irrigation systems, *Irrigation efficiency, *Model studies, Soil-water movement, Subsurface irrigation, Orifice flow, Orifices.

Two mathematical models describing one-dimensional flow were developed. One considered the consumption of water by roots. For the assumed distribution of the root consumption with time and depth, the 10-cm (4-in.) deep source provided better water distribution than did 20-and 30-cm (8-and 12-in.) deep sources. Irrigation from zero depth, as in the case of trickle irrigation, appeared to be the best system for the given conditions. Plugging of emitters by particulate materials decreased as the cross-sectional area of the emitter opening was increased. Less than 0.06 atm (1 psig) vacuum had little effect on the flow of emitters tested. Higher vacuum amounts caused the reopening of plugged orifice emitters, but caused plugging of labyrinth emitters. Vacuum-induced plugging of labyrinth emitters resulted from accumulation of silt and fine sand within the flow path. Operation at higher pressures caused limited flow recovery. A theory was proposed for determining pressure distributions in drip laterals where water is uniformly distributed along the lateral's length. The theory provided acceptable design in two tests. Computer-derived design curves were developed. Because 1000 or more emitters may be required for subirrigation of each acre, emitters need to be both inexpensive and resistant to plugging. Four experimental emitters were designed and constructed. A modification of one microtube emitter is being produced commercially.

75:03F-058
CROP PRODUCTION FUNCTION DETERMINATIONS AS INFLUENCED BY IRRIGATION AND NITROGEN FERTILIZATION USING A CONTINUOUS VARIABLE DESIGN,
Bauder, J.W., Hanks, R.J., James, D.W.
North Dakota State University, Fargo, ND 58102.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1187-1192, November-December 1975. 3 Fig, 6 tab, 18 ref.

Descriptors: *Irrigation, *Irrigation effects, *Nitrogen, *Nutrients, Fertilizers, Fertilization, Crop production, Soil water, Moisture stress.

Continuous variable (CVD) and randomized block, split plot (RBSD) designs were used to produce data from which production functions were developed relating corn yield to soil water and nitrogen fertilizer. Data were collected at Logan, Utah in 1972 and Farmington, Utah in 1973. The CVD water and nitrogen treatments, respectively, were sequential or continuous and not randomized. The design is compact but has some statistical uncertainty. The CVD had 7 or 8 soil-water (W) levels and 22 or 24 nitrogen (N) levels compared to 4 W and 5 N levels for RBSD. The area used for the RBSD was 3 or 4x that used for the CVD. The data analyzed for the CVD led to the same conclusions as the analysis of the RBSD. The production function (regression equation) at Logan was different from that at Farmington except when comparisons were made on a relative basis.

75:03F-059
EFFECT OF LIME ON BORON TRANSPORT TO AND UPTAKE BY COTTON,
Scott, H.D., Beasley, S.D., Thompson, L.F.
Department of Agronomy, University of Arkansas, Fayetteville, AR 72701.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1116-1121, November-December 1975. 1 Fig, 5 tab, 2 equ, 22 ref.

Descriptors: *Boron, *Cotton, *Crop response, Soils, Soil investigations, Soil chemistry, Moisture stress, Adsorption, Diffusivity, Lime.

Deficiencies of Boron have occurred in cotton grown in coarse textured soils during periods of moisture stress and in those soils which have been recently limed. These B deficiencies have generally been attributed to a decrease in soil B availability to cotton. As a result a greenhouse experiment was conducted to study (i) the amounts of adsorption and diffusivity rates of B in two silt loams and (ii) B absorption by cotton grown in pots. Addition of lime increased B adsorption occurred on the seventh day after its addition but did not differ appreciably from the one day equilibration time. The adsorption data could not be accurately described by the Langmuir adsorption equation.

75:03F-060
POTASSIUM IN AN ARID LOESSIAL SOIL: CHANGES IN AVAILABILITY AS RELATED TO CROPPING AND FERTILIZATION,
James, D.W., Weaver, W.H., Roberts, S., Hunter, A.H.
Utah State University, Logan 84322.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1111-1115, November-December 1975. 8 Fig, 2 tab, 7 ref.

Descriptors: *Potassium, *Fertilizers, *Fertilization, Nutrients, Crop production.

Two K fertilizer experiments were initiated in 1961 in arid central Washington on a Shano silt loam soil site that had been leveled to accommodate irrigation. The experiments were continued for 3 years and utilized rates of K fertilizer up to 330 kg K/ha in a randomized complete block design. By 1964 there existed a wide range of Kst (soil test K) as a result of the fixed random K treatments and partial exposure of K-deficient subsoils. That year the experiments were altered to completely randomized designs using both Kst and K fertilizer rates as controlled variables. The experiments were continued through 1970, providing an evaluation of the effects of crop management and K fertilization on soil K reserves.

75:03F-061
INITIAL RELEASE OF NITROGEN FROM UREAFORM UNDER FIELD CONDITIONS,
Hade, A., Kafkafi, U., Peled, A.
Division of Soil Chemistry and Plant Nutrition, Institute of Soils and Water, Agricultural Research Organization, The Volcani Center, Bet Dagan, Israel.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1103-1105, November-December 1975. 3 fig, 2 tab, 10 ref.

Descriptors: *Nitrogen, *Nitrite, Nutrients, Crop response, Fertilizers, Fertilization, Ureas.

The mineralization of ureaform in the soil has been observed during the three weeks following application in a small plot of a banana plantation at two different seasons of the year. In the cooler season ammonium and nitrite accumulated and persisted for 2 weeks. In the warmer season, only ammonium accumulated during two days. The rate of mineralization, calculated as first-order reaction, was greater at the higher temperature, but the rate constants were about 10 times greater in the field than in previous laboratory experiments. The reasons for this are probably changes in microbiological activity and mineralization of nitrogen from sources other than the fertilizer.

75:03F-062
REACTION PRODUCTS OF POLYPHOSPHATES AND ORTHOPHOSPHATES WITH SOILS AND INFLUENCE ON UPTAKE OF PHOSPHORUS BY PLANTS,
Subbarao, Y.V., Ellis, R. Jr.
Department of Agronomy, Kansas State University, Manhattan, Kansas 66506.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1085-1088, November-December 1975. 7 fig, 3 tab, 8 ref.

Descriptors: *Phosphorus, *Corn, Crop response, Nutrients, Fertilizers, Fertilization, Chemical reactions.

Ammonium polyphosphate and diammonium phosphate were compared as sources of P for corn in a growth chamber experiment with an alkaline-calcareous soil and a slightly-acid soil. Reaction products of the two P sources in soils and soil extracts correlated with results obtained in the growth chamber. Applied P increased dry weights, uptake of P by the plants, and available soil P in the slightly acid soil. Ammonium and magnesium orthophosphates, formed as reaction products in the laboratory experiments when the two P fertilizer materials were added, should furnish sufficient P for plant growth.

75:03F-063
EFFECTS OF UNEVEN SPREADING OF FERTILIZER ON CROP YIELDS,
Lutz, J.A. Jr.; Jones, G.D.; Hawkins, G.W.; Hutcheson, T.B. Jr.
Virginia Polytechnic Institute and State University, Blacksburg, VA; Dept. of Agronomy.
Agronomy Journal, Vol. 67, No. 4, p 526-529, July-August 1975. 3 fig, 7 tab, 5 ref.

Descriptors: *Fertilization, *Fertilizers, *Nutrients, Crop response, Crop production, Virginia, Corn, Barley, Soybeans, Wheat.

Bulk spreading of fertilizer does not always result in a uniform distribution over the entire area. The extent to which this distribution affects crop yield is unknown and should be investigated. As a result, nine experiments were conducted over a period of several years to determine the effects of uneven distribution of fertilizer on the yield of corn, barley, soybeans, and wheat. The investigations were conducted in the three physiographic areas of Virginia. Soil types varied from thick surface phase sandy loams to a clay loam. Four spread patterns commonly obtained in farming operations and a no-fertilizer treatment were used. In 1970, corn on Frederick silt loam and Tatum silt loam responded to fertilization, but there was no significant differences in yields among spread patterns on Lodi loam. Significant differences in yields among spread patterns on Davidson clay loam were observed.

75:03F-064
EFFECT OF IRRIGATION, LIME, AND FERTILITY TREATMENTS ON THE YIELD AND CHEMICAL COMPOSITION OF SOYBEANS,
Lutz, J.A. Jr., Jones, G.D.
Virginia Polytechnic Institute and State University, Blacksburg VA. Dept. of Agronomy.
Agronomy Journal, Vol. 67, No. 4, p 523-526, July-August 1975. 6 tab, 5 ref.

Descriptors: *Soybeans, *Crop response, *Nutrients, *Fertilization, Potassium, Phosphorus, Irrigation, Irrigation effects.

Data are available on the effects of surface applied plant nutrients on the yield, quality, oil, and protein contents of soybean seed and on the chemical composition of the soybean leaves. Very little information is available, however, on the effects of irrigation and plow sole (30.5 cm) placement of plant nutrients on these same plant characteristics. In order to determine the effects of irrigation and plow sole placement of P, K, lime, and micronutrients on the quality, yield, oil, and protein contents of soybean seeds and on the chemical composition of the leaves, a field experiment was conducted for 3 consecutive years.

75:03F-065
EFFECT OF METHOD OF NITROGEN APPLICATION ON CORN (ZEA MAYS L.) GROWN ON IRRIGATED SANDY SOILS,
Rehm, G.W., Wiese, R.A.
Northeast Station, University of Nebraska, Concord.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1217-1220, November-December 1975. 1 fig, 2 tab, 10 ref.

Descriptors: *Nitrogen, *Nutrients, *Fertilizers, Fertilization, Corn, Crop response, Irrigation, Leaching.

Studies were conducted in 1970 and 1972 to determine the influence of method of nitrogen application on corn production on irrigated, sandy soils. Conventional preplant and sidedress treatments were compared to situations where either preplant or sidedress applications were supplemented with added N in the irrigation water. Grain yields were recorded and the NO3(-)-N distribution to 150 cm in the soil profile was measured at the end of the growing season. The influence of method of application on corn yields was related to the textural profile of the soil. For a sandy soil with no accumulation of fine-textured material, the application of N with the irrigation water increased grain yields. Also, the corn crop recovered a higher proportion of the applied N when some fertilizer N was added with the irrigation water. For a soil type characterized by an accumulation of fine textured material at 50-70 cm below the surface, method of N application had no influence on yield since the downward movement and loss of NO3(-)-N was restricted by the layer of fine-textured material. The data show that the application of a portion of the N fertilizer requirement with the irrigation water should be a recommended practice for corn production on sandy soils having no accumulation of fine-textured material.

75:03F-066
ON A DERIVABLE FORMULA FOR LONG-WAVE RADIATION FROM CLEAR SKIES,
Brutsaert, W.
Cornell University, Ithaca, New York. School of Civil and Environmental Engineering.
Water Resources Research, Vol. 11, No. 5, p 742-744, October 1975. 1 fig, 1 tab, 16 ref.

Descriptors: *Radiation, Mathematical studies, Mathematics.

A derivation is presented for the effective atmospheric emissivity to predict downcoming long-wave radiation at ground level under a clear sky and for a nearly standard atmosphere. The results are in good agreement with those obtainable with empirical formula based on water vapor pressure and temperature. However, the proposed formulation has the advantage that its simple functional form is based on physical grounds without the need for empirical parameters from radiation measurements. Also, in contrast to the empirical equations, it may be adjusted in a simple way to reflect changes in climatic and atmospheric conditions.

75:03F-067
WATER LOSSES FROM AN IRRIGATED SOYBEAN FIELD BY DEEP PERCOLATION AND EVAPOTRANSPIRATION,
Carvallo, H.O., Cassel, D.K., Bauer, A.
North Dakota State University, Fargo, ND. Department of Soil Science.
Water Resources Research, Vol. 11, No. 2, p 267, April 1975. 2 fig.

Descriptors: *Soybeans, *Irrigation, *Irrigation effects, Return flow, Evatranspiration, North Dakota, Crop production.

Soil-water flux below the root zone of a soybean crop was measured in the field at Oakes, North Dakota, during the crop season in 1972 for four water treatments. Amounts of 0, 30.6, 38.1, and 47.0 cm of water were applied in addition to the 19.5-cm rainfall occurring during the growing season to treatments W-1, W-2, W-3, and W-4, respectively. Specific in situ unsaturated hydraulic conductivity for each plot of the Maddock sandy loam soil and hydraulic gradients measured with tensiometers in the field during the growing season were used to compute the soil-water flux.

75:03F-068
FIELD CHANNELS: A KEY TO BETTER INDIAN IRRIGATION,
Easter, K.W.
Minnesota Univ., St. Paul, Minnesota. Dept. of Agricultural and Applied Economics.
Water Resources Research, Vol. 11, No. 3, p 389-392, June 1975. 3 tab, 8 ref.

Descriptors: Irrigation, Irrigation effects, Surface irrigation, Flood irrigation, Irrigation systems.

Two different programs which attempted to improve water use and management were evaluated in eastern India. The improvement was through the installation of field channels in existing flood irrigation projects. The channels gave farmers better control over water on each field. The analysis highlights the importance of technically trained people and low-cost project designs in making projects viable. Annual net returns of 300-350 rupees per acre were obtained in the Sambalpur villages with investment costs of only 38 rupees per acre. The contrasting pilot project in Raipur had a much lower profit potential due to high investment costs. The analysis adds support to the proposition that India should spend more public funds on modest improvements in existing flood irrigation systems and much less on large new irrigation projects.

75:03F-069
THE EFFECTS OF STREAMFLOW VARIATION ON PRODUCTION AND INCOME OF IRRIGATED FARMS OPERATING UNDER THE DOCTRINE OF PRIOR APPROPRIATION,
Anderson, R.L.
Colorado State University, Ft. Collins, CO 80521. Economics Department. United States Dept. of Agriculture, Natural Resource Economics Division, Economic Research Service.
Water Resources Research Vol. 11, No. 1, p 15-22, February 1975. 5 fig, 11 tab, 4 ref.

Descriptors: Irrigation, Irrigation practices, Streamflow, Prior appropriation, Water supply, Runoff.

Many irrigated farms dependent upon varying streamflow frequently encounter periods of inadequate water supply because streamflow is inadequate to serve all water rights. Streams fed by mountain snowmelt exhibit sharply peaked hydrographs. During the peak runoff period most water rights can be served. Thereafter streamflow declines rapidly, and many of the later water rights are denied water. Farms that are prohibited from diverting water suffer reduction in crop yields and income. To get the most benefit from varying flow, streams must be closely monitored so that as many rights as possible can be served with the original flow and the return flow that occurs.

75:03F-070
EFFECTS OF SOIL-MOISTURE REGIMES ON THE GROWTH OF BARLEY,
Day, A.D., Thompson, R.K.
Arizona University, Tucson, Arizona. Agricultural Experiment Station.
Agronomy Journal, Vol. 67, No. 3, p 430-433, May-June 1975. 4 tab, 9 ref.

Descriptors: *Moisture stress, *Soil water, *Barley, Crop response, Irrigation, Irrigation effects.

Effects of soil-moisture stress at three different stages of growth (jointing, flowering, and dough) on grain yield, grain quality, and plant growth of spring barley planted in November were studied under the field conditions at Mesa, Arizona. The experiment was conducted to determine the limitations to irrigation water conservation in a semiarid environment. Four by four Latin square designs were used to compare four irrigation treatments. Effects of soil-moisture stress for 7 days at the jointing, flowering, and dough stages of growth and/or until 100% of available water in the first 3 feet of soil was depleted were compared with plants not stressed.

75:03F-071
OPTIMIZATION OF WATER USE EFFICIENCY UNDER HIGH FREQUENCY IRRIGATION -- I. EVAPOTRANSPIRATION AND YIELD RELATIONSHIP,
Howell, T.A., Hiler, E.A.
New Mexico State University, Las Cruces, Agricultural Engineering Department.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 5, p 873-878, September-October 1975. 2 fig, 5 tab, 6 equ, 20 ref.

Descriptors: *Irrigation, *Irrigation efficiency, *Irrigation practices, Irrigation systems, Evapotranspiration, Crop response, Grain sorghum, Irrigation effects, Lysimeters, Moisture stress.

An experiment was conducted in 1973 to determine the sensitivity of grain sorghum to water deficits in three selected growth stages under high frequency irrigation. Field lysimeters containing undisturbed soil cores were utilized. Rainfall was removed as a variable by an automatic shelter system. Irrigation treatments consisted of a well-watered control, a variable level of deficit in all three growth periods (SDI treatment), and six additional treatments were irrigated three times per week. Measurements were made to determine irrigation amount, storage depletion, and drainage amount; hence total crop water use could be determined. Three empirical yield models (two multiplicative type and one additive type) were compared to the experimental data. All of these models were quite similar in formulation and represented the experimental data accurately within the range of the data.

75:03F-072
DESIGN OF IRRIGATION RUNOFF RECOVERY SYSTEMS,
Stringham, G.E., Hamad, S.N.
Utah State University, Logan, Utah. Department of Agricultural Engineering and Irrigation Engineering.
Journal of the Irrigation and Drainage Division, Vol. 101, No. IR3, p 209-219, September 1975. 3 fig, 16 equ, 5 ref, 1 append.

Descriptors: Irrigation, Furrow irrigation, Surface irrigation, Return flow, Water conservation, Irrigation practices, Irrigation efficiency, Irrigation systems.

Adequate furrow irrigation requires runoff and the runoff can be controlled by using an irrigation runoff recovery system. Such systems have been designed in the past and used successfully. However, one of the problems encountered has been the adjustment of set size and furrow discharge rates to accommodate the intermittent flows from recirculating pumps. A design technique has been developed that permits a constant inflow to all furrows throughout the entire irrigation, requires changes in set size only twice, permits using a constant discharge from the pump once it is turned on, and uses all the water applied to the field, i.e., there is no net runoff from the field. This is accomplished by irrigating the entire first set from the inflow water and collecting the runoff in a storage reservoir. All of the remaining sets, except the last one, are irrigated by both the supply stream and the runoff water, recirculated by pump, and the last set is irrigated entirely by pumped runoff water. At the end of the last set, no water should remain in the storage reservoir. The technique provides ways to determine the number of furrows in each set, the volume of storage required in the storage reservoir, and the recirculating pump flow rate. This design technique will be an aid to irrigation engineers in the design of the IRRS.

75:03F-073
HERBIGATION,
Fischbach, P.E.
Nebraska University, Agricultural Engineering and Extension Irrigation, Lincoln, Nebraska.
Irrigation Journal, Vol. 25, No. 3, p 22-24, May-June 1975.

Descriptors: Herbicides, Irrigation, Irrigation practices, Irrigation systems, Irrigation efficiency.

Herbigation? Yes, a new-coined word. What is it? Herbigation is the science of applying herbicides through an irrigation system. It's a new way to save food production costs and labor.

75:03F-074
COMPUTER IRRIGATION,
Irrigation Journal, Vol. 25, No. 5, 3 pages, September-October 1975.

Descriptors: Irrigation, Scheduling, Computers, Computer programs, Irrigation practices.

When to irrigate and how much water to use on crops are decisions which will be made by computer during the current growing season for a test group of cooperating farmers in western and southeastern Colorado. The farmers are part of a computer-controlled irrigation program being conducted by the U.S. Interior Department's Bureau of Reclamation. Program Coordinator Jerry Buchheim is in charge of the project, which is monitored by the bureau's giant Control Data CYBER 74 computer at the Federal Center in Denver.

75:03F-075
HERBICIDES AND SURFACE IRRIGATION-DO THEY MAKE A TEAM?,
Schleicher, G.
The Webb Company, 1999 Shepard Road, St. Paul, MN 55116
Irrigation Age, Vol. 9, No. 5, 3 pages, February 1975.

Descriptors: *Herbicides, *Surface irrigation, *Furrow irrigation, Irrigation, Irrigation practices.

Herbigation through center pivot sprinkler irrigation works. That's the consensus of a growing number of irrigation specialists and irrigating farmers who have put the concept to use on a surprising variety of crops. But what about the surface irrigator, the operator who uses gated pipe or an open ditch to deliver water to his fields? Can herbicides be applied as efficiently at ground level as they are through a sprinkler nozzle? That question has been the target of several private and university studies in the last year or two. And while conclusive results are still somewhat sketchy, it's beginning to look like surface herbigation may eventually take a place in the irrigating farmer's stack of management tools.

75:03F-076
HE'S AUTOMATING DEAD LEVEL IRRIGATION,
Rose, R.
The Webb Company, 1999 Shepard Road, St. Paul MN 55116
Irrigation Age, Vol. 9, No. 6, 3 pages, March 1975.

Descriptors: *Surface irrigation, *Furrow irrigation, Irrigation, Irrigation practices, Irrigation efficiency.

Dana Fisher is an enthusiastic innovator. Almost before researchers have put their tentative stamp of approval on an applicable development, it's at work in a big way on Fisher's 5,000-acre Palo Verde Valley farm. It's that type of non-traditionalism that created Fisher's open-ditch system of automated irrigation on dead level fields. Eye-opening labor and water savings triggered the 160-acre development.

75:03F-077
MAKING SURFACE IRRIGATION WORK WITH AUTOMATION,
Alleman, R.
Irrigation Age, Vol. 9, No. 7, p 38-39, April 1975.

Descriptors: *Surface irrigation, *Furrow irrigation, Irrigation, Water conservation, Irrigation efficiency, Irrigation systems.

Nebraska farmers Ed Thiessen and Ted Regier have moved to irrigation systems that cut labor to the minimum, save water, and may increase corn yields. Sound like new sprinklers? Wrong. Both have installed automatic surface systems.

75:03F-078
A NEW TECHNIQUE FOR CONSERVING WATER,
Humpherys, A.
Idaho
Irrigation Age, Vol. 9, No. 7, p 24-25, April 1975.

Descriptors: *Water conservation, Irrigation, Irrigation systems, Irrigation efficiency, Irrigation practices.

As our knowledge of soils and plants increases and as we learn more about the effects of the field environment and cultural treatments on plant growth and production, we will need to modify present tillage, irrigation, and cultural practices to take advantage of new concepts. A practice getting recent attention consists of using short, frequent irrigations which vary from daily irrigations to irrigating every two or three days.

75:03F-079
SPRINKLERS FOR MULTIPLE USE,
Hagood, M.
Washington
Irrigation Age, Vol. 9, No. 8, p 11-12, May-June 1975.

Descriptors: Sprinkler irrigation, Irrigation, Irrigation systems, Irrigation practices, Fertilization.

Multiple use for full utilization of our natural resources has been popular for several years. The multiple use concept for irrigation systems can also be beneficial. Besides nonagricultural uses of sprinkler systems, there are many production aspects which provide potentially better utilization. These include the fertilizer, soil amendment and pesticide application, and climate control. And, although single line systems can be used for purposes other than irrigation, the real dividends come when systems are automated. Solid sets and center pivots, particularly, lend themselves to sophisticated and extra dividend benefits. Multiple purpose systems make it possible to save labor, material, and energy by requiring fewer trips across the field with machinery and by timely chemical application.

75:03F-080
THE IRRIGATOR'S COUNSELOR.
Schleicher, G.
The Webb Company, 1999 Shepard Road, St. Paul MN 55116.
Irrigation Age, Vol. 10, No. 1, p 20-26, October 1975.

Descriptors: Energy conservation, Water conservation, Irrigation, Scheduling, Sprinkler irrigation.

This past summer, over 400 High Plains farmers improved their fertility programs, upgraded their irrigation efficiency, and reduced weed, insect and disease problems without spending a single extra hour in the field. How? By hiring a professional consulting firm at McCook, Nebraska, to do their worrying for them.

75:03F-081
IRRIGATION SCHEDULING FOR ENERGY AND WATER CONSERVATION.
Heermann, D.F.
Agricultural Research Service-USDA, Fort Collins, Colorado.
Sprinkler Irrigation Association, 1975 Annual Technical Conference Proceedings, p 7-11, Hyatt-Regency Hotel, Atlanta, Georgia, February 23-25, 1975. 2 fig, 14 ref.

Descriptors: *Water conservation, *Energy conservation, *Scheduling, Sprinkler irrigation, Surface irrigation.

Many irrigation scheduling schemes have been developed to help the irrigator conserve water and increase yields. The more complex schumes have been shown to conserve considerable amounts of water and energy. However, even the simpler schemes must not be overlooked since they also are good management tools. The benefits of irrigated agriculture in food production will undoubtedly force continued irrigation development throughout the world.

75:03F-082
THE FUTURE OF AUTOMATED SPRINKLER IRRIGATION SYSTEMS.
Splinter, W.E.
Nebraska University, Agricultural Engineering Department, Lincoln, Nebraska.
Sprinkler Irrigation Association, 1975 Annual Technical Conference Proceedings, p 42045, Hyatt-Regency Hotel, Atlanta, Georgia, February 23-25, 1975. 8 ref.

Descriptors: *Sprinkler irrigation, *Automatic control, *Automation, Irrigation, Irrigation practices, Irrigation efficiency.

Sprinkler irrigation, especially automated forms of sprinkler irrigation, will play a key role in supplying the U.S. with adequate food resources to meet the expanding demands internally and to provide diplomatic and balance-of-trade impact on the international scene. As menial labor to provide shovel work for irrigation becomes increasingly scarce, there will be continued pressures to increase initial investment to automate irrigation.

75:03F-083
DRIP IRRIGATION PROGRESS AND PROBLEMS.
Aljibury, F.K.
California University, Cooperative Extension, Parlier, CA
Sprinkler Irrigation Association, 1975 Annual Technical Conference Proceedings, p 46-47, Hyatt-Regency Hotel, Atlanta, Georgia, February 23-25, 1975.

Descriptors: Irrigation, Irrigation methods, Irrigation practices, Water conservation.

Most drip irrigation installations in California and elsewhere, were made to solve specific problems of water cost, water shortage, soil conditions, labor expense and automated water delivery. The acceptance of this method would have been limited, however, without favorable crop response, production, and favorable costs.

Field experience shows that drip irrigation is most advantageous under conditions marginal for other methods of water application.

75:03F-064
DRIP IRRIGATION FILTRATION PROBLEMS AND RESEARCH,
Wilson, D.L.
Controlled Water Emission Systems, El Cajon, California.
Sprinkler Irrigation Association, 1975 Annual Technical Conference Proceedings, p 51-57, Hyatt-Regency Hotel, Atlanta, Georgia, February 23-25, 1975. 4 ref.

Descriptors: Irrigation water, Irrigation, Irrigation systems, Filtration, Filters, Water quality.

One of the major concerns in drip irrigation is filtration. It is fairly well agreed that proper filtration makes the difference between an effective drip installation and one that is ineffective with many problems and poor efficiency. In this paper, the drip filtration problem is examined and defined. Existing equipment and processes to treat the filtration requirement are reviewed. Some of the equipment and processes under development are discussed.

75:03F-065
"TUNING IN" SAVES WATER, BOOSTS YIELDS ON SANDY SOILS,
Ross, E.
Irrigation Age, A Webb Publication.
Irrigation Age, Vol. 10, No. 3, November-December 1975. p 18-20.

Descriptors: Irrigation, Irrigation efficiency, Irrigation water, Sprinkler irrigation, Scheduling.

Any irrigator who can get more yield while using less water is on the right track to higher profits. Bill Condon, Sterling, Colorado rancher/farmer, has been in the desired position for three years. By using an irrigation scheduling program developed by Dr. Dale Heermann, and other Agricultural Research Service colleagues, stationed at Ft. Collins, Colorado, Condon has been able to get consistent yield increases (yields are now between 150 and 160 bushels of corn per acre). Water usage has dropped by about 6 inches per year, and that, says Condon, "adds a year of life to a center pivot every 5 years because we save about 7 revolutions per year."

Section XVI

WATER QUANTITY MANAGEMENT AND CONTROL

CONTROL OF WATER ON THE SURFACE (GROUP 04A)

75:04A-001
SOLUTIONS FOR UNCONFINED NON-DARCY SEEPAGE,
Volker, R.E.
James Cook University of North Queensland, Townsville (Australia). Department of Engineering.
Journal of the Irrigation and Drainage Division, Proceedings of American Society of Civil Engineers, Vol. 101, No. IR1, Proceedings Paper 11203, p 53-65, March 1975. 8 fig, 1 tab, 17 ref, 3 append.

Descriptors: *Porous media, *Darcys law, *Model studies, Digital computers, Hydraulic conductivity, Reynolds number, Wells, *Seepage, Transmissivity, Permeameters, Flow nets, Drainage, Rock fill, Boundary processes, Piezometers, Head loss.

Numerical and experimental studies of non-Darcy flow in porous media were examined. Laboratory experiments with a screened gravel included radial flow to a simulated well and a sector and two-dimensional flow through a bank with vertical sides in a flume. Permeameter tests on the gravel were used to estimate coefficients in the nonlinear relation between head loss and velocity. Results were presented of analyses performed by a finite difference solution of the appropriate partial differential equation boundary value problem. The flow nets and discharges obtained were compared with the experimental results and the corresponding solutions for Darcy flow.

75:04A-002
ESTIMATING LAND USE CHARACTERISTICS FOR HYDROLOGIC MODELS,
Gluck, W.R. and McCuen, R.H.
Rummel, Klepper and Kahl, Baltimore, Maryland.
Water Resources Research, Vol. 11, No. 1, p 177-179, February 1975. 2 tab, 9 ref.

Descriptors: *Land Classification, *Land use, *Urban mapping, *Model studies, Watersheds(Basins), Rainfall-runoff relationships, Urban hydrology, Suburban areas, Hydrology, Equations, *Estimating.

Equations for estimating land use characteristics used in hydrologic models were presented. The method presented was intended as a reliable alternative to the more costly, time-consuming process of aerial photography interpretation. Application of the equations permits prediction of future land use configurations. Data input takes the form of demographic characteristics (e.g., population density of housing density) which is frequently available from planning agencies or others.

75:04A-003
PARAMETERS FOR ESTIMATING ANNUAL RUNOFF AND SOIL LOSS FROM AGRICULTURAL LANDS IN RHODESIA,
Elwell, H.A., and Stocking, M.A.
Agricultural Engineering Centre, Salisbury (Rhodesia).
Water Resources Research, Vol. 11, No. 4, p 601-605, August, 1975. 2 fig, 4 tab, 13 ref.

Descriptors: *Runoff, *Rainfall-runoff relationships, *Runoff forecasting, *Soil erosion, *Semiarid climates, Africa, Subtropic, Agricultural runoff, Rainfall, Rainfall disposition, Soil conservation, Rainfall intensity, Vegetation effects, Impact(Rainfall), Grasslands, Cultivation, Arid Climates.

Cumulative values of rainfall energy, momentum, and depth were investigated as predictors of annual soil loss and runoff from selected arable and grazing land field trial plots. Energy parameters were the most accurate predictors of soil loss from bare soils, explaining 96.4% of the variation in results from a clay loam and 80.0% from a sandy soil. Momentum, energy, and precipitation depth parameters were all close in their prediction of soil loss from the vegetated plots or as predictors of runoff from both bare and vegetated conditions, and consequently, precipitation depth parameters were selected as being the most practical for soil loss and runoff estimation under the conditions investigated. Percentage vegetal cover was shown to be an additional important variable on grassland.

75:04A-004
SCREENING MODEL FOR CONJUNCTIVE-USE SYSTEMS,
Bowden, A.R.; Meredith, D.D.
Harza Engineering Company, Chicago, Illinois.
Journal of the Hydraulics Division Vol. 101 No. HY10 p 1343-1355, October 1975.
3 fig, 5 tab, 16 ref, 2 append.

Descriptors: *Model studies, Groundwater, Surface waters, Planning, Simulation analysis.

This paper presents a preliminary screening model for use in planning conjunctively operated ground-water and surface water systems. The model is a minimum cost flow network model for which the out-of-kilter algorithm can be used as a solution technique. To present the model and computational strategy, an example problem is formulated and analyzed to illustrate how the model can be used to answer planning and management queries.

75:04A-005
AUTOMATED VALVES FOR SURFACE IRRIGATION PIPELINES,
Humpherys, A.S.; Stacey, R.L.
Agricultural Research Service, Kimberly, Idaho. Snake River Conservation Research Center.
Journal of the Irrigation and Drainage Division, American Society of Civil Engineers, Vol. 101, No. IR2, p 95-109, June, 1975. 15 fig, 3 ref, append.

Descriptors: *Hydraulic valves, *Distribution systems, *Irrigation engineering, *Surface irrigation, *Flow control, Automation, Irrigation systems, Pipes, Water distribution(Applied), Irrigation practices, Irrigation design, Irrigation operation and maintenance, Conveyance structures, Irrigation, Water delivery, Operating costs, Water control, Irrigation efficiency, Design criteria.

Automatic irrigation valves have been developed to control the discharge from a field pipeline turnout into either gated pipe or directly into irrigation borders. Design information for 6-inch, 8-inch and 10-inch valves is given. Two types of water-inflatable bladders are used to open and close the valves which are designed to operate with water from the irrigation pipeline at pressures up to approximately 12 pounds per sq inch. Small 1-inch pilot valves, operated by a 6 volt dc battery powered motor, are used to control opening and closing of the irrigation valves. This motor/pilotvalve unit can be used with mechanical and electronic timers, commercial irrigation controllers, or radio transmitter/receiver units.

75:04A-006
PORTABLE, ADJUSTABLE FLOW-MEASURING FLUME FOR SMALL CANALS,
Replogle, J.A.
U.S. Water Conservation Laboratory, 4331 East Broadway, Phoenix, AZ 85040.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, December 15-18, 1975, Chicago, Illinois. 25 p, 5 fig, 2 append, 5 ref.

Descriptors: *Flow measurement, *Flumes, *Portability, *Water measurement, Flow rates, Water conservation.

A portable flume-site survey flume was constructed and used to verify siting of permanent metering flumes. The portable system consists of a trapezoidal throat that can be raised and lowered in a flowing field ditch to establish limits of unsubmerged operation and backwater effects on upstream structures. Mechanical solutions to problems of maintaining gage-zero on a movable throated flume, stilling well readout, and movable seals between ditch and flume were presented. A family of concrete throat sections, differing only in height of installation from the flume floor, were recommended for the permanent installations. Flows between about 0.5 cfs (0.01 m^3/s) and 25 cfs (0.7 m^3/s) can be measured with the portable system. Satisfactory operation can be achieved with less than 4 inches (10 cm) head loss to the canal system. Permanent structures can be installed with high assurance that they will operate as intended, be convenient enough to be routinely used and rugged enough to remain reliable and accurate.

75:04A-007
REDUCED IRRIGATION TAILWATER RUNOFF FOR INCREASED WATER-USE EFFICIENCY,
Schneider, A.D., New, L.L., Musick, J.T.
Agricultural Research Service, United States Department of Agriculture, Bushland, Texas.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, December 15-18, 1975, Chicago, Illinois. 16 p, 6 fig, 4 tab, 8 ref.

Descriptors: *Return flow, *Irrigation effects, *Irrigation practices, *Tailwater, Water conservation, Irrigation water.

Duration of tailwater runoff from 570-m long graded furrows did not significantly affect field average yields of grain sorghum grown on a slowly permeable soil. Irrigation water-use efficiency varied inversely with the time of tailwater runoff. Conclusions from this study were: 1. The field average grain sorghum yield on 570-m long irrigated furrows of Pullman clay loam was not seriously affected by tailwater runoff duration. Major yield reduction occurred only in the lower 100 m of the field; 2. Limiting or reducing tailwater runoff increases the irrigation water-use efficiency of grain sorghum grown on graded-furrow irrigated Pullman clay loam. The results should be applicable to other drought-resistant crops on similar soil; and, 3. A limited tailwater runoff irrigation procedure permits irrigating larger acreages with a fixed water supply.

75:04A-008
ANNOTATED BIBLIOGRAPHY ON TRICKLE IRRIGATION,
Smith, S.W., Walker, W.R.
Colorado State University, Fort Collins, Colorado. Agricultural Engineering Department, Environmental Resources Center.
Information Series No. 16, June 1975. 61 p.
(See 75:03F-039)

75:04A-009
AN IMPLICIT METHOD TO SOLVE SAINT VENANT EQUATIONS,
Greco, F., Panattoni, L.
IBM Scientific Center, Pisa (Italy).
Journal of Hydrology, Vol. 24, p 171-185, 1975. 5 fig, 2 tab, 31 equ, 9 ref.

Descriptors: *Mathematical studies, Mathematics, Hydrographs.

An implicit numerical method for solving Saint Venant equations has been defined for an application relating to the river Arno. This method exploits the linearity in the discharge of the mass equation, by means of which it is possible to express the discharge as a function of the water level and to use this expression in the equation of motion. Then the resulting non-linear equation for a grid element on the (x,t) plane contains only the water levels as unknown quantities. The solution of the system of equations for the entire reach, by the use of the Newton iteration method, is facilitated by the particular form of the matrix of the coefficients. The rapid rate of convergence and the limited storage allocation are characteristics of this implicit scheme. This method has been compared with other implicit methods based on the same grid of points.

75:04A-010
SOUTH PLATTE RIVER FLOW CORRELATIONS,
Glover, R.E.
Colorado State University, Fort Collins, Colorado.
Department of Civil Engineering
Journal of the Irrigation and Drainage Division, Vol. 101, No. IR3, p 175-186, September 1975. 2 fig, 1 tab, 3 equ, 15 ref, 1 append.

Descriptors: *River flow, *River system, Rivers, River forecasting, Colorado, Water resources.

An effective administration of the water resources of the South Platte River Valley will require a quantitative advance evaluation of the effects to be expected from decisions to be made. To serve this need a method of computation is proposed. In developing this method excellent precedents have been followed. One case will be cited to illustrate the procedure. Isaac Newton had been developing mathematics which would permit the computation of an orbit (4). He states: ". . . and in the same year (1666) I began to think of gravity extending to the orb of the moon . . . having thereby compared the force requisite to keep the moon in her orb with the force of gravity at the surface of the earth and found them to answer pretty nearly." Note that when he completed it he had an experimentally based law. In the present case, where direct experiment is precluded because of serious practical difficulties it can still be possible to develop a technically sound expression for the flow of ground water and to establish its validity by testing it against the historic performance of the river. If computed and observed flows are in agreement the validity of the procedure is confirmed. This was the procedure followed.

75:04A-011
WHAT'S IN THE FUTURE FOR SPRINKLER IRRIGATION?,
Splinter, W.E.
Nebraska University, Agricultural Engineering Dept.
Irrigation Age, Vol. 9, No. 6, 2 pages, March 1975.

Descriptors: Irrigation, Sprinkler irrigation, irrigation practices, Irrigation systems.

Man's recognition of the need for water for plants appears nearly as old as agriculture. Ancient works in Asia Minor indicate that quite complex irrigation systems were developed several thousand years ago. Many of the ancient systems are still in use. The use of external energy to move water appeared first with the use of wind powered pumping plants. Since its inception irrigation has required high inputs of effort and management.

75:04A-012
COMPARING THREE MECHANICAL MOVE SPRINKLERS WITH GATED PIPE,
Irrigation Age, Vol. 9, No. 8, p 28-29, May-June 1975.

Descriptors: *Sprinkler irrigation, *Furrow irrigation, Irrigation, Irrigation systems.

Paul Fischbach, University of Nebraska extension irrigationist, recently spelled out the positive sides of mechanical move sprinklers vs. gated pipe during the Sprinkler Irrigation Association's annual technical conference in Atlanta.

75:04A-013
CALIFORNIANS FIGHT SALT WITH WATER,
Irrigation Age, Vol. 9, No. 9, p 14-15, July-August 1975.

Descriptors: Irrigation, Furrow irrigation, Sprinkler irrigation, Soil-salinity, Salinity, Soils.

Confronted with two techniques for reducing salt levels while preparing soil in the Imperial Valley, a Brawley, California farm manager has opted for a combination of both: row irrigation and sprinkler irrigation. But his emphasis is still on sprinkling, which has become popular for germinating a crop.

Section XVII

WATER QUANTITY MANAGEMENT AND CONTROL

GROUNDWATER MANAGEMENT (GROUP 04B)

75:04B-001
A DISCRETE KERNEL GENERATOR FOR STREAM-AQUIFER STUDIES,
Morel-Seytoux, H.J., and Daly, C.J.
Colorado State University, Fort Collins, Department of Civil Engineering
Water Resources Research, Vol. 11, No. 2, p 253-260, April 1975. 5 fig, 3 tab, 22 ref, 2 append.

Descriptors: *Surface-groundwater relationships, *Mathematical models, *Cost comparisons, *Aquifer management, *Computer models, *Conjunctive use, Economics, Water rights, Drawdown, Water wells, Porosity, Transmissivity, Regulation, Alluvial aquifers, Model studies, Finite element analysis.

A finite difference model of the behavior of an aquifer without stream interaction was developed as a first-state component of a management model of a stream-aquifer system. The model was not built as a usual simulator but as a discrete impulse response generator. Once the basic response coefficients were generated, the finite difference model was no longer necessary to simulate the behavior of the aquifer. Any aquifer response (e.g., return flow to a given reach for a given week) was expressed as an explicit function of the pumping rates. A complete description of the 'discrete kernel generator' was provided including the basic equations, truncation error propagation, accuracy, and run costs.

75:04B-002
NEW EQUATIONS FOR DETERMINING THE FORMATION CONSTANTS OF AN AQUIFER FROM PUMPING TEST DATA,
Boulton, N.S., and Streltsova, T.D.
Sheffield University (England), Department of Civil and Structural Engineering.
Water Resources Research, Vol. 11, No. 1, p 148-153, February 1975. 2 fig, 5 tab, 11 ref, 1 append.

Descriptors: *Groundwater, *Pumping, *Aquifer testing, Confined water, Aquicludes, Permeability, Drawdown, Storage coefficient, Transmissivity, Hydraulics, Hydrologic properties, Equations, Sandstones.

New equations were given, based on an extended theory, that take into account the following factors: the compressibility and anisotropy of the main aquifer; the partial penetration of the abstraction well; the depth at which the drawdown in an observation well is measured; the existence of a low-permeability layer, called 'the aquitard,' above the aquifer; and the saturated and unsaturated zones above the water table. A practical method of evaluating the formation constants for an aquifer from pumping test data was fully discussed. Type curves based on the new equations were used to analyze data from a pumping test in the thick Bunter sandstone formation of Shropshire (Great Britain). A correction for the water derived from storage within the abstraction well was found to be necessary.

75:04B-003
ANALYSIS OF FLOW TO AN EXTENDED FULLY PENETRATING WELL,
Javandel, I., and Zaghi, N.
Pahlavi University, Shiraz (Iran).
Water Resources Research, Vol. 11, No. 1, p 159-164, February 1975. 10 fig, 10 ref.

Descriptors: *Groundwater, *Water wells, *Potential flow, Hydraulics, Groundwater potential, Fourier analysis, Groundwater movement, Water yield, Safe yield, Discharge(Water).

An analytic solution was derived yielding the potential distribution in a bounded confined aquifer pumped by a well that was radially extended at the bottom. An exact solution for the rate of discharge was found by which the effect of local radial extension on the increase of the pumping rate was studied. Solutions were evaluated numerically, and the results were presented graphically in terms of dimensionless parameters. The results showed that production rate is doubled in some cases by extending the bottom of the well.

75:04B-004
WELL PUMPING IN UNCONFINED AQUIFERS: THE INFLUENCE OF THE UNSATURATED ZONE.
Kroszynski, U.I., and Dagan, G.
Technion-Israel Institute of Technology, Haifa, Faculty of Civil Engineering.
Water Resources Research, Vol. 11, No. 3, p 479-490, June 1975. 7 fig, 1 tab, 18 ref.

Descriptors: *Groundwater, *Water table aquifers, *Unsaturated flow, *Unsteady flow, *Mathematical studies, Capillary conductivity, Hydraulic conductivity, Soil water movement, Aquifer characteristics, Aquifer testing, Numerical analysis, Finite element analysis, Drawdown, Equations, Approximation method, Wells.

An approximate analytical solution describing transient flow toward a partially penetrating well pumped at a constant discharge in a rigid, homogeneous, anisotropic, unconfined aquifer of infinite radial extension and finite depth, considering flow in the unsaturated zone above the free surface, was presented. The characteristic hydraulic properties of the unsaturated zone, namely the retention and hydraulic conductivity curves, were described by analytical expressions that depended on a parameter which roughly represented the effective thickness of the unsaturated zone. To check the validity of the approximate analytical solution, the problem, free of such approximations, was solved numerically by a finite element scheme for a representative particular case. Comparison between analytical and numerical solutions showed excellent agreement. The influence of the unsaturated zone was found to be negligible for most common cases encountered. In the marginal cases of very shallow rigid aquifers and of soils with particularly large unsaturated effective thickness, the influence of the unsaturated zone upon drawdown was found to be significant only at relatively short times, close to the pumping well and close to the free surface.

75:04B-005
SCREENING MODEL FOR CONJUNCTIVE-USE SYSTEMS.
Hamdan, A.S., Meredith, D.D.
Harza Engineering Company, Chicago, Illinois.
Journal of the Hydraulics Division Vol. 101 No. HY10 p 1343-1355, October 1975.
3 fig, 4 tab, 16 ref, 2 append.
(See 75:04A-004)

75:04B-006
ITERATIVE METHOD OF DETERMINING AQUIFER CONSTANTS.
Gill, M.A.
Ahmadu Bello University, Zaria, Nigeria, Department of Civil Engineering.
Journal of the Irrigation and Drainage Division Vol. 101, No. IR1, p 81-85
March 1975. 1 fig, 1 ref, 3 append.

Descriptors: *Aquifer characteristics, *Aquifers, *Aquifer testing, *Mathematical studies, Theis equation.

In the proposed method, it is possible to consider as many terms in the series of Eq.1 as may be significant for calculating the aquifer constants. Therefore, the method can be considered as a refinement or extension of Jacob's method in which only the first two terms of the series are considered. It can be compared with the Theis method in which the "match" of the drawdown curve with the type curve is obtained graphically. In the proposed method, the "match" is obtained algebraically. The aquifer constants determined by the proposed method satisfy

Eq. 3 for the two selected values of u and r^2/t. Because the two points are selected from a smooth curve passing through the test data, the fit generally is good at all the other points also.

75:04B-007
PRIVATE CONSTRAINTS ON GROUNDWATER CONTAMINATION,
Walker, W.R., Cox, W.E.
Virginia Polytechnic Institute and State University, Blacksburg. Water Resources Research Center.
Journal of the Hydraulics Division Proceedings of ASCE, Vol. 101, No. HY10, p 1333-1341, October, 1975. 39 ref.

Descriptors: *Groundwater, *Water rights, *Water quality control, *Water pollution control, Hydrologic aspects, Legal aspects, Water pollution sources, Water supply.

While water rights have been supplemented by direct governmental controls in the case of surface waters, protection of groundwater quality has been inadequate. Various judicial decisions regarding the rights of a groundwater user to an uncontaminated water supply are presented. The interpretations of court cases showed no clear patterns of legal action. In many cases, potential sources of groundwater pollution are essentially unregulated, and in cases where penalties for groundwater contamination do exist, there is no means for assuring recovery of losses. A 1970 survey indicated that groundwater constituted about one-third of public water supplies and provided about 95% of water used by 41 million people served by private domestic systems in the United States. It was strongly recommended that more comprehensive and effective controls are needed to supplement the mechanism of water rights and to protect the domestic water supplies.

75:04B-008
HAMMER SEISMIC TIMING AS A TOOL FOR ARTIFICIAL RECHARGE SITE LOCATION,
Bianchi, W.C., Nightingale, H.I.
Agricultural Research Service, Fresno, California. Water Management Research.
Soil Science Society of America Proceedings, Vol. 39, No. 4, p 747-751, July-August 1975. 4 fig, 4 tab, 14 ref.

Descriptors: *Seismology, *On-site investigations, *Groundwater, *Artificial recharge, *Water spreading, *California, Seismic properties, Seismic waves, Travel time, Seismic studies, Alluvial aquifers, Aquifers, Geophysics, Exploration, Equipment, Groundwater recharge, Recharge ponds, Sites.

Hand carried hammer impact seismic timing equipment utilizes the physics of seismic wave refraction to explore stratigraphic changes deeper than those found on soils maps. In alluvial areas, artificial recharge and liquid waste disposal sites were selected from sandy, single-grained soil series noted for their high water-transmitting properties through the surface 2m. The surface horizon seismic velocity exhibited by these soils in the San Joaquin Valley had a very narrow range (V sub 1 = 315-440 m/sec), which gave good definition to the refraction off the second horizon (V sub 2 = 610-2,150 m/sec). Accurate information on depth and horizontal continuity of this second horizon could be obtained in areal surveys. A third horizon may often be described, but its areal continuity is usually masked by intermediate discontinuous layers above it of equal or lesser refractivity. All groundwater recharge by water spreading.

75:04B-009
DRAWDOWN SOLUTIONS FOR SIMULTANEOUS DRAINAGE AND ET,
Skaggs, R.W.
North Carolina State University, Raleigh. Department of Biological and Agricultural Engineering.
Journal of the Irrigation and Drainage Division, American Society of Civil Engineers, Vol. 101, No. IR4, Proceedings Paper 11804, p 279-291, December 1975. 9 fig, 16 ref, 2 append.

Descriptors: *Drainage, *Seepage, *Drains, *Evapotranspiration, *Water table, Subsurface drainage, Ditches, Drawdown, Subsurface drains, Tiles, Drainage effects, Numerical analysis, Graphical methods, Deep percolation, Dupuit-Forchheimer theory, Groundwater movement, Soil water movement, Hydraulic conductivity.

Numerical methods were used to solve the nonlinear Boussinesq equation for water table drawdown between parallel drains. The solutions were compared to other methods of predicting drawdown for initially horizontal, parabolic, and elliptical profiles, and good agreement was found with methods that considered the nonlinear aspects of the governing equation. Solutions were presented in graphical form for simultaneous drainage and ET or deep seepage. Example problems were solved to show the use of these solutions for evaluating the effect of ET or deep seepage on water table drawdown and for considering this effect when predicting drain spacings to satisfy a predetermined drawdown rate. The solutions were also used in an example to explain apparent discrepancies in field tests of drain spacing equations.

75:04B-010
GROUND-WATER RECHARGE RATES FROM THERMOMETRY,
Nightingale, H.I.
Agricultural Research Service, Fresno, California.
Ground Water, Vol. 13, No. 4, p 340-344, July-August 1975. 5 fig, 4 tab, 12 ref.

Descriptors: *Groundwater, *Recharge, *Temperature, *Recharge ponds, *Water temperature, *California, Air temperature, Percolating water, Fourier analysis, Percolation, Seepage, Infiltration, Groundwater movement, *Artificial recharge, Statistics.

Basin artificial groundwater recharge rate at the Leaky Acres Recharge Project in Fresno, California, was evaluated by Fourier analysis of temperature variations of air, basin water, and groundwater. The weekly mean basin water temperature correlated well (r=0.982) with weekly mean air temperature. Weekly mean temperature data of the air, basin water, and recharged groundwater showed that the first harmonic curve was satisfactory for determining the times of minimum and maximum temperature when convective transfer of heat was considered. The lag time between maximum basin water temperature and maximum groundwater temperature at a 16 m depth, showed water moved at a thermal tracer velocity of 20.8 cm/day. The corresponding infiltration rate measured by the falling-head method in study area basins was 18.5 cm/day. This indicated that under suitable conditions with simple field instrumentation groundwater thermometry can be used to estimate the rate and direction of recharged water movement.

75:04B-011
UPCONING OF THE SALT-WATER-FRESHWATER INTERFACE BENEATH A PUMPING WELL,
Chandler, R.L., McWhorter, D.B.
Colorado State University, Fort Collins. Department of Agricultural Engineering.
Ground Water, Vol. 13, No. 4, p 354-359, July-August 1975. 8 fig, 1 tab, 9 ref.

Descriptors: *Saline water-freshwater interfaces, *Water wells, *Penetration, Pumping, Saline water, Water table, Anisotropy, Isotropy, Optimization, Permeability, Entrainment, Dupuit-Forchheimer theory, Mathematical models, Model studies, Numerical analysis, Boundaries(Surfaces), Equations, Density, Pressure head, Discharge(Water).

The upconing of saline water in response to pumping from an overlying layer of fresh water was investigated by numerical integration of the governing differential equation. The transition zone between the fresh and saline water was idealized as an abrupt interface. Full consideration of the nonlinear boundary conditions on the water table and interfacesurface was included for steady flow toward partially penetrating pumping wells in both isotropic and anisotropic aquifers. There exists an optimum well penetration into the fresh-water layer which permits maximum discharge without salt-water entrainment. The optimum penetration increases as the vertical permeability is reduced relative to the horizontal permeability. The maximum well discharge obtainable without salt-water entrainment is greater for aquifers with a reduced vertical permeability than for isotropic aquifers, a result that contrasts with previously published conclusions. Previous analyses which linearise the boundary condition on the interface overestimated the critical discharge.

75:04B-012
CONJUNCTIVE AVAILABILITY OF SURFACE AND GROUND WATER IN THE ALBUQUERQUE AREA, NEW MEXICO: A MODELLING APPROACH,
Brutsaert, W.F., Gebhard, T.G.Jr.
Maine University, Orono. Department of Civil Engineering.
Ground Water, Vol. 13, No. 4, p 345-353, July-August 1975. 9 fig, 4 tab, 6 ref.

Descriptors: *Surface-groundwater relationships, *Conjunctive use, *Model studies, *Simulation analysis, *Available water, *New Mexico, Water management(Applied), Aquifer systems, Computer models, Forecasting, Regression analysis, Groundwater, Water resources development, Groundwater basins, Groundwater potential.

The relationship of dynamic ground-water availability and aquifer behavior under projected stresses was modeled by a groundwater system simulator based on a mass balance of the hydrologic basin. Conditions from extreme dry to extreme wet were modeled, combined with a range of different water demands. A vast amount of information was thus obtained in the form of aquifer responses for different conditions. An analogous relationship was constructed from these data by stepwise multiple regression analysis of the change in water-table elevation at the end of the previous time period, and lump factor combining surface-water inflow and outflow, precipitation, and beneficial and nonbeneficial water uses. Other results readily obtainable from the simulation runs were river accretion or depletion curves as a function of time. These curves showed the diversion effects of groundwater pumping upon the river.

75:04B-013
A MULTIPLE-WELL, WATER-LEVEL MEASURING AND RECORDING SYSTEM,
Bolke, H.R., Harr, R.D., Hyde, J.D.
Oregon State University, Corvallis. Forest Research Lab.
Journal of Hydrology, Vol. 27, No. 3/4, p 159-166, December 1975. 4 fig, 1 ref.

Descriptors: *Instrumentation, *Water level recorders, *Remote sensing, Automatic control, Electronic equipment, Water level fluctuations, Piezometers, Electrodes, Observation wells, Measurement, Data collections.

An electronic measuring and recording system was designed to make periodic measurements of water level simultaneously in sixteen small-diameter piezometers. The system can operate unattended from battery power in remote areas for 2-4 weeks. Output data are easily read and are readily adaptable to computer entry for analysis and plotting.

75:04B-014
PHYSICAL FUNDAMENTALS OF THE MIXING OF SOLUTIONS OF POLLUTANTS AND SEWAGE IN POROUS MEDIA,
Klotz, D.
Institut fur Radiohydrometrie der Gesellschaft fur Strahlen- und Umweltforschung mbH, 8042 Neuherberg (Munchen). Ingolstadter Landstrabe 1, Federal Republic of Germany.
Water Research Vol. 9, No. 12, p 783-790, December 1975. 15 fig, 1 tab, 12 equ, 18 ref.

Descriptors: *Water quality, *Groundwater, Pollution, Porous media, Sewage, Diffusion, Aquifer characteristics.

The increasing danger of ground-water pollution by pollutants from the environment and by increasing amounts of sewage requires an exact examination of the mechanisms of distribution and transport within the water-bearing stratum. Two mixing processes occur substantially in case of the simultaneous propagation of two miscible liquids in a porous medium (water-bearing stratum): hydrodynamic dispersion and molecular diffusion. If a region of flow is marked in a liquid (ground-water) flowing through a porous medium with a further liquid (solution of pollutants, sewage) being miscible therewith, this marked region increases as regards its extension during the joint movement of the two liquids. A mixing of the "marking substance" with the flowing liquid occurs, the decrease in concentration of the "marking substance" being a measure for the degree of intermixture.

75:04B-015
DETERMINING OPTIMAL WELL DISCHARGE,
Helweg, O.J.
Colorado State University, Fort Collins.
Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers, Vol. 101, No. IR3, Proceedings paper No. 11568, p 301-308, September 1975. 5 fig, 6 ref, 1 append.

Descriptors: *Wells, *Discharge(Water), *Pumping, *Groundwater, *Irrigation, *Geohydrologic units, Optimization, Methodology, Cost-benefit analysis, Water supply, Drainage, Design, Cost-benefit ratio, Computers, Equations, Drawdown, Project planning, Systems analysis, Evaluation.

The cost of pumping groundwater is a major factor in water supply; it is necessary to pump a given well at the discharge that maximizes the net benefit of the operation. Previous criteria have ignored the economic aspects of the analysis of this problem. This paper presents a method for determining the optimum operating policy of a well, i.e., at which discharge a well owner receives the most water for his money. A computer code, GOPTIM, is included along with an example of the analysis. The case treated is pumping an existing well at the optimum discharge, where drilling the well is a sunk cost. The real world example shows the importance of considering well losses in any analysis. An appendix lists GOPTIM, which can be easily used by most engineering offices to find the optimal discharge of a given well. The choice of criterion for finding the optimal well discharge is important. Application results of the cost-benefit, optimization method developed herein show power costs for a well to be $2,350/yr greater if the well is pumped at two thirds drawdown rather than at the optimal discharge as found using GOPTIM.

Section XVIII

WATER QUANTITY MANAGEMENT AND CONTROL

EFFECTS ON WATER OF MAN'S NONWATER ACTIVITIES (GROUP 04C)

75:04C-001
ENERGY, AGRICULTURE AND WASTE MANAGEMENT.
Jewell, W.J. (Editor)
Cornell University, Department of Agricultural Engineering, Ithaca, New York;
Ann Arbor Science Publishers, Inc. P.O. Box 1425, Ann Arbor, Michigan 48106;
1975. 540 p.

Descriptors: *Energy, *Agriculture, *Waste treatment, *Waste disposal, Food abundance, Feed lots, Engineering.

Agriculture requires significant energy resources for food and fiber production. New energy demands have also been created in controlling wastes to improve environmental quality. Recently, these two areas have been linked by studies that emphasize the possibility of converting wastes to energy sources. This book discusses in detail three main topics: 1) Energy consumed in food production 2) Technology and energy costs of pollution control, and 3) Potential for producing energy from agricultural wastes. An outstanding feature is the large amount of information compiled on anaerobic fermentation, and the discussion of this technology in producing energy from waste. To date, few answers have emerged for the engineers, scientists, and policy makers who must recommend directions for the future of food production, energy use and environmental pollution control--these chapters present one of the first attempts to answer these questions. This volume will be a valuable reference for civil, agricultural, and environmental engineers, water pollution control officials, microbiologists, wildlife biologists, and professors of environmental engineering.

Section XIX

WATER QUANTITY MANAGEMENT AND CONTROL

WATERSHED PROTECTION (GROUP 04D)

75:04D-001
SOIL MOISTURE ACCOUNTING COMPONENT OF THE USDAHL-74 MODEL OF WATERSHED HYDROLOGY,
England, C.B.
Agricultural Research Service, Northeastern Region, United States Department of
Agriculture, Beltsville, Maryland 20705
Water Resources Bulletin, Vol. 11, No. 3, p 559-567, June 1975. 3 fig, 1 tab,
7 ref.

Descriptors: *Soil moisture, *Model studies, Watersheds(Basins), *Hydrology, Watershed management, Oklahoma.

Soil moisture in two layers of soil near Chickasha, Oklahoma, was simulated, using USDAHL-74 Model of Watershed Hydrology. Weekly values computed for both layers compared well with those observed during the 15-month period. Certain key parameters required adjustments in the model which illustrate the need for accurate input information. The experiment demonstrates that the model, which has previously given good results in continuous streamflow prediction on watersheds up to 100 square miles, can also compute soil moisture continuously at a site. This capability suggests other model uses, for example, in monitoring the disposition of applied chemicals.

WATER QUALITY MANAGEMENT AND PROTECTION

IDENTIFICATION OF POLLUTANTS (GROUP 05A)

75:05A-001
URBAN SEDIMENT PROBLEMS: A STATEMENT ON SCOPE, RESEARCH, LEGISLATION, AND EDUCATION,
The Task Committee on Urban Sedimentation Problems of the Committee on Sedimentation of the Hydraulics Division,
American Society of Civil Engineers.
Journal of the Hydraulics Division, Vol. 101, No. HY4, p 329-340, April 1975. 1 tab, 7 ref.

Descriptors: *Sediments, *Sedimentation, Sediment control, Urban runoff, Urbanization.

Erosion and sediment pollution problems are serious in many urban and urbanizing areas because such areas and their waters are important to society; therefore, urban sediment problems need attention. This report hopefully will stimulate progress toward awareness of urban sediment problems.

75:05A-002
PHOSPHATE DETERMINATIONS IN WATERS USING AN ANION EXCHANGE RESIN,
Blanchar, R.W., Riego, D.
Missouri Agricultural Experimental Station, Missouri University, Columbia.
Journal of Environmental Quality, Vol. 4, No. 1, p 45-49, January-March 1975. 5 fig, 4 tab, 10 ref.

Descriptors: *Phosphates, *Water quality, Water quality control.

Amounts of water samples from 1 to 1000 ml were passed through 10-cc columns of 100- to 200-mesh Dowex 1-X8 anion-exchange resin. Orthophosphate was quantitatively removed from the water sample by the resin and could be eluted from the column with 25 ml of 1N HCl. Phosphate in the 1N HCl eluent was reacted with ammonium molybdate, extracted into isobutanol, reduced with SnCl(2), and the optical density of the blue complex measured. The working range of the method was between 1 and 8 micrograms of P. Analysis of water samples indicated that in the 1 to 20 ppb P range an appreciable amount of the phosphate exists as pyro- and tripoly-phosphate. The resin method is not specific for dissolved orthophosphate in water, but may give a more valid estimate than direct reaction with the acid molybdate reagent.

75:05A-003
SOME OBSERVATIONS CONCERNING PREPARATION AND STORAGE OF STREAM SAMPLES FOR DISSOLVED INORGANIC PHOSPHATE ANALYSIS,
Johnson, A.H., Bouldin, D.R., and Hergert, G.W.
Cornell University, Ithaca, N.Y. Dept. of Agronomy.
Water Resources Research, Vol 11, No 4, p 559-562, August, 1975. 1 fig, 9 ref, 4 tab.

Descriptors: *Water analysis, *Phosphates, *Storage, Time, Inorganic compounds, Analytical techniques, Water pollution sources, Trace elements, Water pollution, Phosphorus compounds, Water properties, Freezing, Refrigeration, Pollution identification, New York.

The influence of storage conditons and duration of storage was studied by using about 100 stream samples from Fall Creek collected near Ithaca, New York. Freezing and refrigerated storage were unsatisfactory, since changes in measured concentrations were usually observed after relatively short periods of time (24 hr). An isobutanol extraction procedure is described which minimizes storage problems and is useful for routine analysis of water samples for dissolved inorganic phosphate.

75:05A-004
NITRATE MEASUREMENTS USING A SPECIFIC ION ELECTRODE IN PRESENCE OF NITRITE,
Francis, C.W., and Malone, C.D.
Oak Ridge National Lab., Tennessee.
Soil Science Society of America Proceedings, Vol. 39, No. 1, p 150-151, January-February 1975. 2 fig, 1 tab, 9 ref.

Descriptors: *Nitrates, *Nitrogen compounds, *Analytical techniques, *Instrumentation, *Measurement, Inorganic compounds, Chemicals, Denitrification, Nitrites, Water quality, Colorimetry, Analysis, Estimating, Evaluation, Ions, Electrodes, *Pollutant identification.

The presence of the nitrite anion NO2(-) may lead to a significant error in measuring NO3-N concentrations with a specific ion electrode. Interference by nitrite was eliminated by complexing the nitrite with sulfanilamide in 0.01 N H2SO4. In this manner, nitrate levels can be read directly in concentrations ranging from 10 to 5000 ppm NO3-N. The method is particularly useful in denitrification studies where HCO3(-) and CO3(- -) anions as well as NO2(-) preclude direct NO3-N measurements.

75:05A-005
THE TIME STABILITY OF DISSOLVED MERCURY IN WATER SAMPLES-I. LITERATURE REVIEW,
Jenne, E.A., Avotins, P.
United States Department of the Interior.
Journal of Environmental Quality, Vol. 4 No. 4 p 427-431. October-December 1975. 49 ref.

Descriptors: *Mercury, *Water quality, *Sampling, Bacteria, Preservation.

Conflicts in the published findings of adequacy of various preservation treatments for water samples intended for mercury analysis are common and appear to result from variations in (i) biological effects; (ii) initial concentrations of mercury; (iii) types of containers used; (iv) properties of the water or laboratory solution (particularly, the dissolved organic and reduced metal cation content); (v) duration of experiment; (vi) concentration of preservative; (vii) analysis, whether conducted in the original adequacy employed. Of these variables the biological effects have been overlooked by most investigators.

75:05A-006
MONITORING AGRICULTURAL POLLUTION USING NATURAL FLUORESCENCE,
Lakshman, G.
Saskatchewan Research Council, Saskatoon.
Water Resources Research, Vol. 11, No. 5, p 705-708, October 1975, 9 fig, 1 tab, 7 ref.

Descriptors: *Monitoring, *Fluorescence, Analytical techniques, *Agricultural runoff, *Farm wastes, *Water pollution, Data collections, Measurement, Data transmission, Indicators, Pollutants, Water quality, *Pollutant identification, Fluorometry, Surface runoff, Organic compounds, Organic wastes, Nutrients, Sampling, Feed lots.

Many organic and bio-organic compounds exhibit natural fluorescence in the visible spectrum. In many cases this is strong enough to be used as a technique to monitor the presence of pollutants from animal wastes on land and in water. A number of soil and runoff samples from feedlot wastes have been analyzed for the nature and stability of their natural fluorescence. A strong correlation exists between the fluorescence emission and the water quality parameters such as total carbon (TC), total organic carbon (TOC), and total inorganic carbon (TIC). It can be used in the quantitative measurement of agricultural pollution, and future research should help to exploit the technique for remote sensing applications.

75:05A-007
VALIDITY OF SOIL-WATER SAMPLES COLLECTED WITH POROUS CERAMIC CUPS,
Hansen, E.A.; Harris, A.R.
Forest Service (USDA) Cadillac, Michigan. North Central Forest Experiment Station.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 528-536, May-June 1975. 9 fig, 3 tab, 8 ref.

Descriptors: *Equipment, *Sampling, *Soil water, Pollutants, Nutrients, Phosphorus, Nitrates, Laboratory tests, On-site investigations, Water pollution, Soil contamination, Soil filters, *Pollutant identification, Water quality.

Laboratory and field tests were made to determine if porous ceramic cups collect representative samples of nitrate and phosphate from soil water. Substantial bias and variability were found. Some of the sources of sample bias were sorption, leaching, diffusion, and screening of phosphate ions by the cup walls. Sample variability of nitrate ions was strongly influenced by sampler intake rate, plugging, sampler depth, and type of vacuum system (which simulated different sampler sizes). These factors affect timing of sample collection and, because nutrient concentration in soil water is continually changing, they in turn affect sample concentration. These factors produced as much as a 60% range in sample concentration from 8 samplers installed in a small uniform plot. Added to this variability is an unknown amount of bias representing the difference between the sample concentration and the average drainable soil-water concentration. The many factors affecting the sample concentration together with the demonstrated variability and unknown bias make interpretation of sampler data difficult. To reduce sample variability, samplers should be grouped by intake rate. Short sampling intervals, uniform sampler lengths, and the same initial vacuum should be used for all samplers.

75:05A-008
METHODS AND DATA REQUIREMENTS FOR RIVER-QUALITY ASSESSMENT,
Rickert, D.A.; Hines, W.G.; McKenzie, S.W.
Geological Survey, Portland, Oregon.
Water Resources Bulletin, Vol. 11, No. 5, p 1013-1039, October 1975. 5 fig, 1 tab, 12 ref.

Descriptors: *Water resources, *Planning, *Management, *River basins, *Water quality, Dissolved oxygen, Communication, Simulation analysis, Mathematical models, Mapping, Systems analysis, Decision making, Oregon, Environmental effects.

The U.S. Geological Survey is conducting an intensive river-quality assessment of the Willamette River basin, Oregon. The objectives are to (1) define a practical framework for conducting comprehensive river-quality assessments, (2) develop and document methods for evaluating basin-development alternatives in terms of potential impacts on river quality, (3) determine the kinds and amounts of data required to adequately assess various types of river quality problems, and (4) apply the framework, data, and methods to assess the existing or potential river-quality problems of the Willamette River basin. Considered herein are objectives 2, 3, and 4, by examining the rationales behind the selection and application of methods and the design of data programs for assessing specific river-quality problems. The rationales are those developed for assessing (1) the effect of population and industrial growth and resulting waste discharges on river-dissolved oxygen, (2) the potentially harmful effects on land and river quality of accelerated erosion resulting from intensive land-use development, and (3) the potential for nuisance algal growth. The goal of the assessment program and, thus, the content of the rationales is to provide technically sound information that is appropriate and adequate for resource planning and management.

75:05A-009
SEDIMENT ROUTING FOR AGRICULTURAL WATERSHEDS,
Williams, J.R.
Agricultural Research Service, Temple, Texas.
Water Resources Bulletin, Vol. 11, No. 5, p 965-974, October 1975, 6 tab, 16 ref.

Descriptors: *Sediment yield, *Agricultural watersheds, *Soil erosion, *Settling velocity, *Texas, Sheet erosion, Rill erosion, Gully erosion.

A sediment routing technique was developed to route sediment yield from small agricultural watersheds (less than or equal to 10 sq mi) through streams and valleys to the outlet of large watersheds (less than or equal to 1000 sq mi). The procedure was based on the modified universal soil loss equation and a first order decay function of travel time and particle size. Deposition was dependent upon settling velocities of the sediment particles, travel time, and the amount of sediment in suspension. Sediment routing increases sediment yield prediction accuracy and allows determination of subwatershed contributions to the total sediment yield. Also the locations and amounts of floodplain scour and deposition can be predicted. Another advantage of sediment routing is that measured sediment yield data are not required. The procedure performed satisfactorily in test routings on two Texas blackland watersheds. More tests were planned with data from other physiographic areas.

75:05A-010
SAMPLERS FOR MONITORING RUNOFF WATERS,
Manges, H.L., Hixon, C.C.
Kansas State University, Manhattan, Kansas.
Presented at the 1975 Winter Meeting of the American Society of the Agricultural Engineers, December 15-18, 1975, Chicago, Illinois. 10 p, 4 fig, 9 ref.

Descriptors: *Runoff, *Sampling, *Water sampling, Water analysis, Water pollution effects, WAter pollution control.

A sampler is badly needed for collecting a proportional sample of runoff water for laboratory analysis. Pollutant load in runoff would be calculated from sample volume and pollutant concentration measurements. A sampler was designed and built which divided flow with short tubes. In laboratory tests, sampling ratio became constant after decreasing with increasing flow rates for unsubmerged flow and was constant for submerged flow. Sampling ratio was quite variable during field testing because of debris clogging the reservoir below the short tubes. A sampler using orifices surrounded by short tubes in place of the short tubes alone for dividing flow had a slightly better sampling ratio for unsubmerged flow and a constant sampling ratio for submerged flow.

75:05A-011
BACTERIAL FLORA OF SALINE AQUIFERS,
Willis, C.J., Elkan, G.H., Horvath, E., Dail, K.R.
North Carolina State University, Raleigh. Department of Microbiology.
Ground Water, Vol. 13, No. 5, p 406-409, September-October 1975. 1 tab, 10 ref.

Descriptors: *Bacteria, *Methane bacteria, *Analytical techniques, *Aquifers, *Microorganisms, *Saline water, Chromatography, Sulfur bacteria, Anaerobic bacteria, Aerobic bacteria, Pollutant identification, Chemistry, Instrumentation, Methane, Analysis, On-site investigations, Florida, Surface waters, North Carolina, Soils, Pollutants, Observation wells, Sampling, Water pollution, Industrial wastes, Artesian aquifers, Injection wells, Waste disposal, Liquid wastes.

The bacterial flora of three unpolluted saline aquifers were examined. Aerobic, anaerobic, and facultative microorganisms were isolated and classified to genus. The organisms isolated were those commonly found in surface water and soil. Methanogenic bacteria were present in all aquifers.

75:05A-012
A SEMIAUTOMATED PROCEDURE FOR THE DETERMINATION OF PHOSPHORUS IN WATER, WASTE WATERS AND PARTICULATES,
Canelli, E., Mitchell, D.G.
New York State Department of Health, Albany.
Water Research, Vol. 9, No. 12, p 1093-1098, December, 1975. 1 fig, 10 ref, 4 tab.

Descriptors: *Phosphorus compounds, *Water analysis, Analytical techniques, Water, Waste water(Pollution), Dissolved solids, Phosphorus, Phosphates, Silicates, Water chemistry, Water properties, Colorimetry, Chemical analysis, *Pollutant identification, Water pollution sources.

Improved procedures for the determination of total dissolved phosphorus (TDP), particulate phosphorus (PP), and dissolved inorganic orthophosphate (OP) are described. Organic particulate material is solubilized in 5 normal NaOH, and phosphorus compounds are oxidized and mineralized to orthophosphate by persulfate digestion. OP is determined by an improved automated molybdenum blue procedure that does not require sample pH adjustment or a correction for silicate interference in the 0-50 mg Si/liter range. The use of 16-position digestion racks allows 32 TDP or PP samples to be digested in about 1 and 4 hr, respectively. Detection limits in micrograms of phosphorus/liter are OP, 2; TDP, 5; and PP, 1. Waste water samples were analyzed for TDP and PP by the nitric acid-sulfuric acid procedure and by the proposed method. There was no significant difference between the two sets of data.

75:05A-013

BACTERIOLOGICAL CRITERIA FOR GROUND-WATER QUALITY,

Allen, M.J., Geldreich, E.E.

Microbiological Quality Control, Water Supply Research Laboratory, U.S. Environmental Protection Agency, National Environmental Research Center, Cincinnati, Ohio 45268.

Ground Water, Vol. 13, No. 1, p 45-51, January-February 1975. 1 fig, 8 tab, 22 ref.

Descriptors: *Groundwater, Groundwater resources, Water quality, Water quality control, Water pollution, Pollution, Potable water.

Although more than 60 million individuals rely upon the absence of microbial pathogens in their marginally-treated or untreated ground-water supplies, an analysis of reported waterborne disease outbreaks for the period 1946-1970 shows that contaminated ground-water supplies were responsible for over 50 percent of the outbreaks. Completed ground-water studies indicate: (1) coliforms and fecal coliforms are present in a significant percentage of improperly located or inadequately protected private supplies, and (2) the apparent absence of coliforms due to the insensitivity of currently available bacteriological methods does not preclude pathogen occurrences. Excessive bacterial populations, normally not encountered in finished water, can suppress coliform detection. For this reason, it is essential that improved bacterial detection methods be developed and other criteria for untreated ground water be explored by comprehensive field investigations and laboratory analysis of ground-water supplies for a variety of bacterial parameters.

75:05A-014

VARIATIONS IN THE NATURAL CHEMICAL CONCENTRATION OF RIVER WATER DURING FLOOD FLOWS, AND THE LAG EFFECT: SOME FURTHER COMMENTS,

Walling, D.E., Foster, I.D.L.

Exeter Univ. (England). Dept. of Geography.

Journal of Hydrology, Vol 26, No. 3/4, p 237-244, August 1975. 3 fig, 2 tab, 7 ref.

Descriptors: *Chemical properties, *Correlation analysis, *Flood flow, Flood routing, Flood peak, Flow characteristics, Hydrographs, Soil moisture, Pollutant identification, Streamflow, Storm runoff, Hydrology, Specific conductivity, Time lag, Water chemistry, Calcium, Magnesium, Sodium, Potassium.

Results from several Devon catchments were used to demonstrate the complexity of variations in the chemical concentration of river water during flood flows. Certain solute species increased rather than decreased in concentration during storm events and the 'chemographs' of those species which exhibited dilution were often complicated by a 'flushing effect.' Some solutes exhibited variable response, evidencing increased and decreased concentrations during different events. Even in small catchments, 'chemograph' response can lag behind streamflow response and examples have been documented where the trough precedes the streamflow peak. Values of 'chemograph' lag between zero and 14.5 hours were found at a gauging station on the Devon River. This variation in lag time was tentatively explained in terms of catchment moisture status. A multivariate relationship was developed between 'chemograph' lag and four hydrologic variables: hydrograph rise, preceding flow level, soil moisture deficit, and a seasonal index.

75:05A-015
DETERMINATION OF TOTAL MERCURY IN SOILS AND SEDIMENTS,
Floyd, M., Sommers, L.E.
Purdue University, West Lafayette, Indiana. Agricultural Experiment Station
and Department of Interior, Office of Water Research and Technology.
Journal of Environmental Quality, Vol. 4, No. 3, 1975. p 323-325, 3 tab, 9 ref.

Descriptors: *Mercury, Soils, Sediments, Pollution, Soil tests, Soil chemistry.

A simple one-step digestion procedure was evaluated for extracting total mercury from soils and sediments. The procedure evaluated involves digesting soil or sediment samples with concentrated HNO3 and 4N K2Cr2O7 (2:1,vol/vol) for 4 hours at 55C and analyzing mercury in the extract by flameless atomic absorption. Recovery of total mercury from diverse samples was comparable to or exceeded that obtained by four alternative total mercury procedures. Essentially quantitative recovery of mercury was obtained when samples were amended with mercuric chloride, methylmercuric chloride, phenylmercuric acetate, and mercuric sulfide. The procedure developed was precise with coefficients of variation ranging from 1 to 3%. Parameters affecting the quantitative extraction of total mercury were studied.

75:05A-016
GROUND-WATER POLLUTION PROBLEMS IN THE NORTHWESTERN UNITED STATES,
van der Leeden, F., Cerrillo, L.A., Miller, D.W.
Geraghty & Miller, Inc. Port Washington, New York 11050.
Publications No. EPA-660/3-75-018, 361 p, 60 fig, 48 tab, 459 ref, 1 append.

Descriptors: *Groundwater, *Groundwater resources, *Pollution, *Water quality, Water quality control, Colorado, Idaho, Montana, Oregon, Washington, Wyoming, Return flow, Water pollution.

An evaluation of ground-water pollution problems has been carried out in six states in the northwest: Colorado, Idaho, Montana, Oregon, Washington and Wyoming. The findings of the investigation indicate that, with the exception of radioactive waste disposal, few cases of ground-water pollution have been investigated in detail. There is a need for baseline water-quality data and systematic evaluation of overall ground-water conditions, especially in urban zones, in areas of petroleum exploration and development, and at locations of mining and industrial activity. The most common natural ground-water quality problems, other than high salinity, are excessive hardness, iron, manganese, and fluoride. Principal sources of man-caused ground-water quality problems in the approximate order of severity are: discharge of effluent from septic tanks and sewage treatment plants, irrigation return flow, dryland farming, abandoned oil wells, shallow disposal wells, unlined surface impoundments, mine tailings and mine drainage, municipal and industrial landfills, and radioactive waste disposal. Other sources that appear to be of less importance but still must be considered include: spills and leaks, application of fertilizers and pesticides, feedlots, and salt-water intrusion. The findings of the investigation indicate that, with the exception of radioactive waste disposal, few cases of groundwater pollution have been investigated in detail.

Section XXI

WATER QUALITY MANAGEMENT AND PROTECTION

SOURCES AND FATE OF POLLUTION (GROUP 05B)

75:05B-001
WATER QUALITY MODELING BY MONTE CARLO SIMULATION,
Brutsaert, W.F.
Maine University, Orono. Department of Civil Engineering.
Water Resources Bulletin, Vol. 11, No. 2, p 226-236, April 1975. 6 fig, 1 tab,
10 equ, 4 ref.

Descriptors: *Water quality control, *Simulation analysis, *Monte Carlo method, *Stochastic processes, *Probability, Streams, Equations, Biochemical oxygen demand, Dissolved oxygen, Mathematical models, Systems analysis, Optimum development plans, Design, Wastes.

The applicability of Monte Carlo simulation to water quality modeling is demonstrated using a simple Streeter-Phelps model. The model accounts for the stochasticity of the input parameters. Triangular probability density function are shown to be useful in case insufficient information is available to define meaningful frequency distributions of input parameters. The model output is presented as probability distributions of stream quality parameters. To demonstrate the usefulness of the technique, a simple, critical DO-deficit problem is set up. The technique is applicable to optimizing design and operation of wastewater treatment systems.

75:05B-002
STOCHASTIC WATER QUALITY CONTROL BY SIMULATION,
Shih, C.S.
Texas University, San Antonio. Division of Environmental Studies.
Water Resources Bulletin, Vol. 11, No. 2, p 256-266, April 1975. 5 fig, 5 tab,
8 equ, 11 ref.

Descriptors: *Water quality control, *Stochastic processes, *Simulation analysis, *Reliability, *River basins, *Management, Probability, Computers, Optimization, Water policy, Standards, Regional analysis, Return flow, Effluents, Treatment facilities, Streams, Decision making, Biochemical oxygen demand, Dissolved oxygen, Costs, Systems analysis, Equations, Mathematical models, *Texas.

In order to handle the probabilistic nature of treated waste effluent characteristics, the reliability associated with a basin-wide quality management goal has been included in the modeling process. Meanwhile, the quantitative and qualitative variations of the irrigation return flows and the urban runoff also exhibit a probabilistic nature in terms of both temporal and spatial measurements. Computer simulation had been utilized in analyzing the reliability and sensitivity of a river basin quality management. A simulation-optimization scheme for the determination of policies in regional water quality management has been developed subject to specific water quality standards. Stochastic quadratic programming techniques were used in the optimization analysis, the objective function consisting of minimizing a convex quadratic cost function including the operating cost, the amortization of capital expenditures and maintenance costs. A series of simulation models describing the statistical water quality control phenomena was developed. Meanwhile, a simulation analysis for the description of the probabilistic nature of the stream quality was developed for the control strategies of the return flows in the regional management system. As an illustration of the applicability of this water quality control approach, the major wastewater treatment facilities in the San Antonio River Basin were analyzed. The sensitivity analysis was conducted to assess the most satisfying strategies for a regional water quality management system subject to probabilistic standards.

75:05B-003
INTEGRATING CHEMICAL FACTORS WITH WATER AND SEDIMENT TRANSPORT FROM A WATERSHED,
Frere, M.H.
Agricultural Research Service, Chickasha, Oklahoma.

Journal of Environmental Quality, Vol. 4, No. 1, p 12-17, January-March 1975. 3 Fig, 1 tab, 18 ref.

Descriptors: *Mathematical models, *Water pollution sources, Sediment transport, Agricultural runoff, *Path of pollutants, Chemicals, Pesticides, Leaching, Soil erosion, Nutrients, Watershed management, Model studies.

A mathematical model that calculates the movement of a chemical as it is transported through or off of an agricultural watershed is described. Loss of the chemical between storms by degradation or volatilization is described by a first-order rate equation. Simple chromatographic theory is used to describe the chemical distribution in the soil during leaching, assuming a linear adsorption to the square root of the distance moved. The concentration at the surface during the storm is calculated to estimate the amounts lost in runoff water and with interrill erosion. It is assumed that rill erosion removes the chemical in proportion to the fraction of the area in rills and to the fraction of the chemical distribution in the soil intercepted by the rills. Mineralization and uptake are an additional source and sink for nitrate between storms. Lithium bromide movement on a microplot was used to examine some features of the model.

75:05B-004
DENITRIFICATION IN LABORATORY SANDY COLUMNS,
Davenport, L.A. JR.; Lembke, W.D.; Jones, B.A. JR.
Soil Conservation Service, Effingham, Illinois
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 1, p 95-100, January-February 1975. 6 Fig, 2 tab.

Descriptors: *Denitrification, *Laboratory tests, *Soil water movement, *Groundwater, Water analysis, Chemical reactions, Nitrates, Model studies, Hydraulic models, Subsurface waters, Confined water, Tile drains, Nutrient removal, Moisture content.

Nitrate was effectively reduced when methanol was added as a substrate material to a slowly moving solution in porous columns. Applied nitrate was removed at a rate of 97.4% during 34 days at 20C and 63% during 27 days at 13C. The use of sawdust as an oxidizable material had little effect upon nitrate removal. The flux was maintained at approximately 0.23 cm/hr. The production of gases which accompanied the denitrification process desaturated the methanol columns and influenced the flow rate. The breakthrough curves observed indicated that there may have been significantly different effective diffusion coefficient for nitrate as compared with chloride. The passage of nitrate and chloride through the columns was accompanied by an increase in redox potential and, in some cases, a discoloration of the effluent. The removal of a high percentage of nitrate at relatively large pore velocities was encouraging for the prospect of removing excess nitrate from soil water in the vicinity of tile drains. While a technique was not described, it could involve a system for water table control with additions of substrate material introduced by surface application or deep plowing.

75:05B-005
WATER AND SALT TRANSFERS IN SUTTER BASIN, CALIFORNIA,
Tanji, K.K.; Henderson, D.W.; Gupta, S.K.; Iqbal, M.; Quek, A.F.
California University, Davis. Department of Water Science and Engineering
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 1, p 111-121. January-February 1975. 6 Fig, 3 tab, 10 ref.

Descriptors: *Water transfer, *Surface-groundwater relationships, *Saline water intrusion, *Salt balance, *Hydrogeology, *Irrigation effects, Saline water-freshwater interfaces, Hydrology, Salinity, Irrigation, Water quality, Connate water, Geohydrologic units, Geology, *California, Model studies, Water table, Return flow.

An analysis of water and salt transfers was conducted in Sutter basin, California. The average drainage index for the hydrologic years 1964-1973 was estimated as

0.62t or -0.08 and the average salt balance index for the hydrologic years 1970-1972 as 2.05t or -1.25. For the 1970 hydrologic year, the flow-weighted average surface input of salts (precipitation and irrigation water) was 0.74 tons per ha-m and the surface output (return flow) was 5.08 tons per ha-m. About 40% of the water and 70% of the salt load in the return flow was estimated to have originated from subsurface origins, mainly rising connate water.

75:05B-006
EFFECTS OF FOREST FERTILIZATION ON TWO SOUTHEAST ALASKA STREAMS,
Meehan, W.R.; Lotspeich, F.B.; Mueller, E.W.
Environmental Protection Agency, Arctic Environmental Research Laboratory, College, Alaska 99701.
Journal of Environmental Quality, Vol. 4, No. 1, p 50-55, January-March 1975. 7 fig, 9 ref.

Descriptors: *Water quality, *Alaska, *Nitrogen, Watersheds(Basins), Fertilization.

Four streams in southeast Alaska were studied to determine the effects of forest fertilization with urea on basic productivity and water quality. An initial, short-term increase in ammonia-nitrogen levels increased and remained high compared to control stream levels during the year following treatment. Concentrations did not approach those considered toxic to aquatic life or unsafe for human consumption. Changes in biomass of periphyton and benthic fauna as a result of fertilization were not detected.

75:05B-007
THE NEEDS FOR WATER QUALITY MODELS ON AGRICULTURAL WATERSHEDS,
Nicholson, H.P.
Southeast Environmental Research Laboratory, United States Environmental Protection Agency, Athens, GA 30601
Journal of Environmental Quality, Vol. 4, No. 1, p 21-23, January-March 1975. 6 ref.

Descriptors: *Model studies, *Watershed management, *Agricultural watersheds, *Water quality, Water quality control.

Man's agricultural activities contribute pollutants to surface and ground water. Preservation of water quality requires greater effort to control these pollutants including eroded soil, agricultural chemicals, oxygen-demanding organic wastes, and sometimes heavy metals and pathogens. Management of nonpoint source agricultural pollutants will require the management of runoff or vertical movement from the source, the efficient selection and use of appropriate pesticides and fertilizers, and the retention of animal wastes and plant residues on the land. Management programs should be planned for complete drainage basins making use of existing conservation programs. Mathematical models now under development will augment current management practices and will enable the application of computer technology to prediction of the consequences of agronomic practices.

75:05B-008
THE WATERSHED APPROACH TO UNDERSTANDING OUR ENVIRONMENT,
Woolhiser, D.A.
United States Department of Agriculture, Fort Collins, CO 80521
Journal of Environmental Quality, Vol. 4, No. 1, p 17-21, January-March 1975. 3 fig, 35 ref.

Descriptors: *Model studies, *Simulation analysis, *Water quality, *Hydrology, Watersheds(Basins), Computer models.

Current approaches used in modeling a particular part of the human environment--the agricultural watershed--are reviewed and questions are raised regarding the objectives, approaches, and interpretation of agricultural water quality models.

Models--either symbolic (mathematical) or material--are essential to understanding and predicting environmental phenomena on agricultural watersheds. Models describing the transport of water, sediment, and chemicals through a watershed system can become very complicated and frequently must be simplified. Simplifications inevitably involve distortion and may make interpretation of model parameters difficult. The use of material models may assist in interpreting the parameters of mathematical models.

75:05B-009
EFFECTS OF SELECTED HERBICIDES ON BACTERIAL POPULATIONS IN NONTREATED AND TREATED WATER,
Yesar, O., Shievely, J.M., Camper, N.D.
Clemson University, Clemson, South Carolina, Departments of Biochemistry and Botany.
Water Resources Bulletin, Vol. 11, No. 2, p 294-299, April 1975. 1 fig, 1 tab, 4 ref.

Descriptors: *Bacteria, *Herbicides, Water supply, Water pollution, Water pollution effects, Water treatment.

Bacterial populations in nontreated and herbicide-treated waters were subjected to three different herbicides. Diuron, Dichlobenil, and diquat were added (100 ml/l) to water samples from two fresh water lakes and two herbicide-treated ponds. Total numbers of bacteria were monitored. Bacterial populations in fresh lake water decreased after herbicide additions; however, final populations were significantly greater than the controls. Similar observations were recorded for bacteria in dichlobenil- and diuron-treated waters. Selective enrichment is probably expressed in these experiments.

75:05B-010
NITRATE, PHOSPHATE, AND POTASSIUM MOVEMENT INTO DRAINAGE LINES UNDER THREE SOIL MANAGEMENT SYSTEMS,
Calvert, D.V.
Florida University, Institute for Food and Agricultural Science, Agricultural Research Center, P. O. Box 248, Fort Pierce, FL 33450
Journal of Environmental Quality, Vol. 4, No. 2, p 183-186, April-June 1975. 3 fig, 4 tab, 13 ref.

Descriptors: *Nitrate, *Phosphate, *Potassium, *Drainage water, *Drainage, *Leaching, Lime, Soil investigations, Fertilizers, Irrigation, Agriculture.

Nitrate, orthophosphate, and potassium concentrations in drainage water were determined from subsurface drains installed in shallow-tilled (ST), (15cm); deep-tilled (DT), (107cm); and deep-tilled and limed (DTL) Florida Oldsmar sand planted to citrus. Total discharge of NO(3)-N was significantly greater from ST plots than either DT or DTL plots. Peak concentrations and discharge of fertilizer nutrients were shown to be a function of rainfall, irrigation, and timing of fertilizations. Deeply incorporated limestone applications into the subsoil tended to increase the NO(3)-N and decrease PO(4)-P discharge over than from deep tillage alone.

75:05B-011
WATER QUALITY IN IRRIGATED WATERSHEDS,
Branson, R.L., Pratt, P.F., Rhoades, J.D., Oster, J.D.
California University, Riverside 92502. Department of Soil Science Agricultural Engineering.
Journal of Environmental Quality, Vol. 4, No. 1, p 33-40, January-March 1975. 1 fig, 5 tab, 48 ref.

Descriptors: *Return flow, *Irrigation, *Irrigation effects, Drainage water, Agricultural watersheds, Surface runoff.

Historically, attention to water quality in irrigated watersheds has been focused on irrigation waters and the relationships of their chemical composition to soil permeability and crop production. Recently, because of environmental concerns, it has become necessary to look beyond the quality of irrigation waters and consider also the quality of waters that drain from irrigated lands. Irrigation agriculture affects drainage-water chemical composition. In turn, drainage waters can influence the quality of receiving waters which may have a variety of beneficial uses to be protected. The two types of drainage waters from irrigated lands, surface runoff and subsurface drainage or percolation water, are characteristically different in composition and chemical concentration. The pollution potential of subsurface drainage waters, with respect to nitrate and total soluble salts is a particular concern. Studies of individual field conditions are providing information that can be extrapolated to show the effects of watershed management on ultimate water quality in receiving stream or ground water. A new concept has been developed concerning irrigation water management to minimize the quantity of salt discharged from irrigated lands and thereby help alleviate water quality degradation associated with disposal of salt-laden subsurface drainage waters.

75:05B-012
NITRATE REDUCTION AND NITRITE UTILIZATION BY NITRIFIERS IN AN UNSATURATED HANFORD SANDY LOAM,
Volz, M.G., Belser, L.W., Ardakani, M.S., McLaren, A.D.
California University, Berkeley, Department of Soils and Plant Nutrition.
Journal of Environmental Quality, Vol. 4, No. 2, p 179-182, April-June 1975.
3 fig, 2 tab, 20 ref.

Descriptors: *Nitrate, *Nitrite, Soil investigations, Nitrification, Soil environment, Soil management, Agriculture, Soils.

In order to discern any relationship between added nitrate and microbial growth in a field plot, a Hanford sandy loam was infiltrated for 5 weeks at a rate of 5 cm/day with a solution containing 100 ppm-N and 1.25 meq/liter Cl(-) as KNO(3) and CaCl(2) respectively. Nitrate -N, NO(2)(-)-N and Cl(-) concentrations in soils solution were determined and corresponding counts of nitrate reducers, denitrifiers, and NH(4)(+)- and NO(2)(-)-oxidizer populations were made. Ratios of measured to applied concentrations for both NO(3)(-)-N and Cl(-) were nearly identical in all solution samples taken from the unsaturated soil profile, i.e., nitrate reduction was not pronounced and NO(2)(-)-N was less than 1 ppm.

75:05B-013
PHOSPHORUS MOVEMENT IN SOILS: SOIL-ORTHOPHOSPHATE REACTION KINETICS,
Novak, L.T., Adriano, D.C.
Cleveland State University, Cleveland, Ohio. Chemical Engineering Department.
Journal of Environmental Quality, Vol. 4, No. 2, p 261-266, April-June 1975.
5 fig, 3 tab, 20 ref, 1 append.

Descriptors: *Model studies, *Adsorption, *Phosphorus, *Waste water treatment, Soil water, Soil chemical properties, Soil chemistry, Kinetics.

This paper presents four models to describe the kinetics of P adsorption-desorption reactions in soils. The mass transfer model, Langmuir kinetics model, and Langmuir-Hinshelwood models were developed and compared with phosphate adsorption data on a soil obtained by batch-shaken flask experiments. For P adsorption times up to 3 hours, the mass transfer and Langmuir kinetics model gave a slightly better fit of the experimental data. These kinetic data probably represent an upper bound for unsaturated flow in soils.

75:05B-014
THE IMPACT OF MOLYBDENUM-ENRICHED IRRIGATION WATER ON AGRICULTURAL SOILS NEAR BRIGHTON, COLORADO,
Jackson, D.R., Lindsay, W.L., Heil, R.D.
Colorado State University, Fort Collins, Department of Agronomy.

Journal of Environmental Quality, Vol. 4, No. 2, p 223-229, April-June 1975. 10 Fig, 4 tab, 25 ref.

Descriptors: *Irrigation water, *Molybdenum, *Soil chemistry, Soil investigations, Agriculture, Colorado, Alfalfa.

The Mo concentration in water, soils, and alfalfa was monitored for one growing season to determine the impact of using Mo-enriched irrigation water near Brighton, Colorado. The concentration of Mo in irrigation water in this area ranged from 37 to 211 ppb. A significant increase of Mo concentration in alfalfa and available soil Mo was observed at one site irrigated with water containing 211 ppb Mo. The Mo concentration in the alfalfa at this site increased during the growing season from 4.3 to 7.2 ppm. This level is below the 10 ppm level considered toxic to livestock. Plant Mo was highly correlated (r=0.94) with resin-extractable Mo in a greenhouse experiment using soils from three of the field sites. Field results were less satisfactory (r=0.51), partially due to limited indigenous levels of Mo in the soils. A simulation model was used to assess the potential hazards of irrigating with water containing from 0 to 600 ppb Mo. The impact of Mo on the Brighton area during one growing season was minimal in relation to uptake of Mo by plants. Further studies are necessary to assess the long term effects of Mo accumulation in soils and irrigated with Mo-enriched waters.

75:05B-015
CALCULATED DRAINAGE WATER COMPOSITIONS AND SALT BURDENS RESULTING FROM IRRIGATION WITH RIVER WATERS IN THE WESTERN UNITED STATES,
Oster, J.D., Rhoades, J.D.
United States Department of Agriculture, Agricultural Research Service, Riverside, CA
Journal of Environmental Quality, Vol. 4, No. 1, p 73-79, January-March 1975. 4 Fig, 3 tab, 29 ref.

Descriptors: *Model studies, *Simulation analysis, Lysimeters, Alfalfa, Leaching, Return flow, Salinity, Saline water, Irri[illegible]tion water.

Drainage water compositions were calculated w[illegible] computer simulation model from irrigation water compositions, leaching fractions, aragonite and gypsum solubilities, and measured partial pressure of CO(2). The calculated compositions were compared with measured values obtained from lysimeters filled with Pachappa soil, cropped with alfalfa, and irrigated with eight synthetic waters typical of rivers in the western U.S. Linear regression analysis, of predicted vs. measured values for Na(+) and SO4(2-) concentrations, sodium-adsorption-ratio, electrical conductivity, and salt burden resulted in essentially one-to-one relationships. The gain in salt burden of drainage water at high leaching fractions due to mineral dissolution was adequately described by assuming the soil solution was saturated with respect to aragonite. Some evidence for Mg(2+) precipitation was found. The utility of the simulation model is demonstrated for evaluating the salinity, sodicity, and pollution hazards of irrigation waters.

75:05B-016
REGIONAL SEWERING AND GROUNDWATER QUALITY IN THE SOUTHERN SAN JOAQUIN VALLEY,
Schmidt, K.D.
Water Resources Bulletin, Vol. 11, No. 3, p 514-525, June 1975. 4 fig, 9 ref.
(See 75:05C-001)

75:05B-017
THE NITROGEN BALANCE OF ARCTIC TUNDRA: PATHWAYS, RATES, AND ENVIRONMENTAL IMPLICATIONS,
Barsdate, R.J., Alexander, V.
Alaska University, Fairbanks, Department of Marine Science.
Journal of Environmental Quality, Vol. 4, No. 1, p 111-117, January-March 1975. 1 Fig, 5 tab, 43 ref.

Descriptors: *Nitrogen, *Alaska, *Leaching, *Denitrification, Ecosystems

The magnitude of the inputs and exports of nitrogen was estimated for the tundra ecosystem at Barrow, Alaska. Based on new data and on previous investigations, annual input of nitrogen from all sources was 93.4 mg N/m(2) per year, with the most important sources being nitrogen fixation (75%) and ammonia in summer rain (18%). The low input of nitrogen by rain and snow results from both low annual precipitation and extremely low concentrations of nitrogen compounds in precipitation. Despite the meager nitrogen supply, the estimated retention is over 80% of the input reflecting insignificant leaching due to the impermeable permafrost substrate, low precipitation, and restricted lateral movement of water over and through the nonfrozen soils. Denitrification also is low, at least partially due to nutrient deficiency. Interpretations of these data in respect to the sensitivity of the environment to perturbations, suggest that resource development or other activities which would have minor or negligible effects in temperature latitudes, could alter substantially the nitrogen balance of this arctic ecosystem.

75:05B-018
A GALERKIN-FINITE ELEMENT TECHNIQUE FOR CALCULATING THE TRANSIENT POSITION OF THE SALTWATER FRONT,
Segol, G., Pinder, G.F., and Gray, W.G.
Princeton University, N.J. Department of Civil and Geological Engineering.
Water Resources Research, Vol. 11, No. 2, p 343-347, April 1975. 7 fig, 13 ref.

Descriptors: *Saline water intrusion, *Groundwater movement, *Finite element analysis, *Mathematical models, Simulation analysis, Mass transfer, Path of pollutants, Convection, Mixing.

The set of nonlinear partial differential equations that describe the movement of the saltwater front in a coastal aquifer may be solved by the Galerkin-finite element method. Pressure and velocities are obtained simultaneously in order to guarantee continuity of velocities between elements. A layered aquifer may be modeled either with a functional representation of permeability or by a constant value of permeability over each element.

75:05B-019
AN EMPIRICAL METHOD OF ESTIMATING THE RETENTION OF PHOSPHORUS IN LAKES,
Kirchner, W.B., and Dillon, P.J.
Toronto University (Ontario). Department of Zoology.
Water Resources Research, Vol. 11, No. 1, p 182-183, February 1975. 1 fig, 1 tab, 7 ref.

Descriptors: *Nutrients, *Phosphorus, *Model studies, *Lakes, Water balance, Surface waters, Hydrologic systems, *Canada, *Estimating.

The relationship between phosphorus retention and several other lake and watershed parameters was examined for 15 Canadian lakes. Multiple linear regressions were first attempted, but the model developed from the best correlation would have required extensive field measurements for accurate predictive use. Therefore, nonlinear relationships were investigated, resulting in a model relating the areal water load q sub s in meters per year of a lake to its phosphorus retention coefficient R sub p: R sub p = 0.426 exp(-0.271 q sub s) + 0.574 exp (-0.00949 q sub s). This model was found to be theoretically sound, and the predicted and measured values were in close agreement with a correlation coefficient of 0.94. The apparently closer relationship of the phosphorus retention coefficient to areal water load than to volumetric water load (or water renewal time) was not explainable.

75:05B-020
ON THE EFFICIENT ALLOCATION OF ENVIRONMENTAL ASSIMILATIVE CAPACITY: THE CASE OF THERMAL EMISSIONS TO A LARGE BODY OF WATER,

Scherer, C.R.
California University, Los Angeles. Department of Engineering Systems.
Water Resources Research, Vol. 11, No. 1, p 180-181, February 1975. 3 fig, 9 ref.

Descriptors: *Economic efficiency, *Thermal capacity, *Lakes, *Water quality control, *Temperature, Standards, Environment, Heated water, Effluents, Flow rate, Costs, Ports, Size, Cooling towers, Powerplants, Marginal costs, Mathematical models, Systems analysis, Methodology, *Waste assimilative capacity, *Thermal pollution.

Considered is the economically efficient level of environmental assimilative capacity in the case of thermal electric rejected heat discharges to large lakes subject to temperature standards. A mathematical model relating heated effluent flow rate and 'near-field' temperature is used to determine maximum diffuser port size. Diffuser costs are developed as a function of discharge velocity, port size being given. Cooling tower costs are also developed for comparison with diffuser costs in selecting an optimal level of thermal assimilative capacity. The relationship between this selection process and optimal power plant siting models is outlined. It is shown that arbitrarily fixing discharge velocity at some 'practical' level will tend to bias the results of these siting models toward overly conservative use of thermal assimilative capacity. This means, available capacity will not be fully exploited, and the cost of a given level of power output will be greater than is necessary.

75:05B-021
WATER QUALITY CHANGES RELATED TO THE DEVELOPMENT OF ANAEROBIC CONDITIONS DURING ARTIFICIAL RECHARGE,
Wood, W.W., and Bassett, R.L.
Geological Survey, Lubbock, Texas.
Water Resources Research, Vol. 11, No. 4, p 553-558, August 1975. 6 fig, 1 tab, 15 ref.

Descriptors: *Artificial recharge, *Water spreading, *Chemical reactions, *Anaerobic bacteria, *Texas, Groundwater recharge, *Water quality, Infiltration rates, Gravitational water, Soil properties, Sulfates, Bicarbonates, Hydrogen ion concentration, Geology, Data collections, Chemical analysis, *Water reuse.

Artificial recharge basins or spreading sites commonly exhibit reductions in infiltration rates after prolonged periods of submergence. This loss in infiltration rate has often been shown to be associated with a large population of anaerobic or facultative anaerobic bacteria in the material underlying the basin floor. An artificial recharge experiment in a spreading basin at Lubbock, Texas, showed a significant change in the chemical quality of recharged water that was associated with the growth of anaerobic bacteria. Sulfate-reducing bacteria reduced the sulfate concentration of the recharge water at this location by 80 mg/liter, and the pH decreased 1 unit during the same time period. The change in chemical quality occurred suddenly and corresponded to a dramatic decrease in the infiltration rate in the basin. These observations on the chemical changes in recharged water make it possible to differentiate between anaerobic bacteria and other causes of reduced hydraulic conductivity in this recharge basin. The anaerobic conditions appear to start at depth and work toward the surface, thereby suggesting a process that involves adsorption of organic material and consumption of dissolved oxygen with depth.

75:05B-022
URBAN LAWN INFILTRATION RATES AND FERTILIZER RUNOFF LOSSES UNDER SIMULATED RAINFALL,
Kelling, K.A., and Peterson, A.E.
Ball State University, Muncie, Indiana. Department of Natural Resources.
Soil Science Society of American Proceedings, Vol 39, No. 2, p 348-352, March-April, 1975. 1 fig, 4 tab, 25 ref.

Descriptors: *Path of pollutants, *Urban runoff, *Fertilizers, *Water pollution sources, *Infiltration, *Rainfall-runoff relationships, Nutrients, Pollutants, Vegetation effects, Storm runoff, Eutrophication, Soil-water-plant relationships, Soils, Infiltrometers, Surface waters, Simulated rainfall.

Infiltration runoff measurements were made on nine urban lawns by using a sprinkling infiltrometer in conjunction with the application of a complete fertilizer at three rates. The amounts of inorganic N,P, and K removed with the runoff water were determined. Results of the infiltration measurements show that the presence of textural and compaction discontinuities within the soil profile, formed during building and lawn construction, was probably the greatest factor affecting infiltration. Where these discontinuities were distinct, water intake was reduced to about 30% of that for a lawn with an undisturbed profile. For lawns with similar infiltration characteristics, a first order relationship appeared to exist between amounts of fertilizer applied and amounts lost. A second order equation, however, best described the relationship between percent of applied fertilizer in the runoff and 90-min cumulative infiltration. When the simulated storm was applied immediately after fertilizer application, fertilizer losses averaged 10.8%; however, when fertilizer application was followed by recommended watering before the intense storm, average losses were reduced to 1.7% of the amount applied.

75:05B-023
NUTRIENT TRANSPORT IN SURFACE RUNOFF AS INFLUENCED BY SOIL COVER AND SEASONAL PERIODS,
Burwell, R.E., Timmons, D.R., Holt, R.F.
Agricultural Research Service, Morris, Minnesota. North Central Soil Conservation Research Center.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 523-528, May-June, 1975. 5 tab, 14 ref.

Descriptors: *Nutrients, *Runoff, *Sediments, Nitrogen, Phosphorus, Potassium, Snowmelt, Precipitation(Atmospheric), Erosion, Agriculture, Chemistry of precipitation, Seasonal, Fertilizers, Surface runoff, Crops, On-site investigations, *Minnesota.

Nitrogen(N), phosphorus (P), and potassium (K) losses in surface runoff water and sediment were determined for five soil cover conditions on a Barnes loam soil in west-central Minnesota. The five soil cover conditions studied were: (1) continuous clean-cultivated fallow, (2) continuous corn, (3) corn in rotation, (4) oats in rotation, and (5) hay in rotation. Losses of water, sediment, and nutrients were determined for three seasonal periods: (1) critical runoff period caused by melting snow and ice, (2) critical erosion period from corn planting to 2 months later, and (3) noncritical runoff-erosion period exclusive of periods 1 and 2. Much of the annual sediment and nutrient losses occurred during the critical erosion period. Snowmelt runoff accounted for much of the annual water and soluble nutrient losses. Average annual quantities of NH4-N and NO3-N contributed by precipitation exceeded the annual losses in surface runoff, but ortho-P losses in surface runoff were greater than the amount contributed by precipitation.

75:05B-024
COMPARISON OF TWO PREDICTIVE NONEQUILIBRIUM ONE-DIMENSIONAL MODELS FOR PHOSPHORUS SORPTION AND MOVEMENT THROUGH HOMOGENEOUS SOILS,
Enfield, C.G., Shew, D.C.
Robert S. Kerr Environmental Research Laboratory, Ada, OK.
Journal of Environmental Quality, Vol. 4, No. 2, p 198-202, April-June, 1975. 5 fig, 1 tab, 21 ref.

Descriptors: *Phosphorus, *Sorption, *Diffusion, *Simulation analysis, *Model studies, Kinetics, Soil chemistry, Soil investigations, Agriculture.

Two models were tested for their ability to predict phosphorus breakthrough curves. The basic difference between the two models is the method of describing the kinetics of sorption. It was found, when comparing theoretically predicted breakthrough curves with experimental breakthrough curves, that the model using a kinetic equation produced a better fit to the experimental data than a first order rate equation.

75:05B-025
FACTORS INFLUENCING NITRATE TRANSFORMATIONS IN SEDIMENTS,
Terry, R.E., Nelson, D.W.
Indiana Agricultural Experiment Station,
Journal of Environmental Quality, Vol. 4, No. 4, p 549-554, October-December 1975.
7 tab, 16 ref.

Descriptors: *Nitrification, *Denitrification, *Eutrophication, Nitrates, Temperature, Sediment.

The effects of environmental and procedural factors (e.g., aeration, size of sample water/sediment ration, nitrate concentration, glucose addition, temperature, and sterilization) on denitrification in lake and reservoir sediments were evaluated by incubation nitrate-amended natural sediments in the laboratory. The standard laboratory procedure adopted for denitrification studies involved the incubation of small samples of sediment (undried) after addition of a nitrate solution. Denitrification in sediment-water samples was not enhanced by continuously purging samples with helium to create artificial anaerobic conditions. Even though glucose additions enhanced denitrification by 25 to 30%, unamended sediments contained sufficient available organic-C for near maximal rates of denitrification. Denitrification in sediments increased with increasing temperature over the range of 5 to 23C. However, significant denitrification occurred at temperatures as low as 5C. The evaluation of factors affecting denitrification in sediment show that the environmental conditions likely to exist in natural sediments are suitable for denitrification. Anaerobiosis and the high organic matter of most sediments create an ideal environment for microbial denitrification. The levels of nitrate in surface water may in part be controlled naturally by denitrification in sediments.

75:05B-026
THE TIME STABILITY OF DISSOLVED MERCURY IN WATER SAMPLES-II. CHEMICAL STABILISATION,
Avotins, P., Jenne, E.A.
United States Department of the Interior, Geological Survey,
Journal of Environmental Quality Vol. 4 No. 4 p 515-519, October-December 1975.
8 fig, 3 tab, 12 ref.

Descriptors: *Bacteria, *Mercury, Water quality, Water pollution, Water pollution sources, Water, Water pollution effects.

Bacteria were found to be the principal cause of instability of mercury in laboratory solutions. The volatilization loss rate increased rapidly after a variable lag period and then leveled off with increasing time. The marked reduction in the loss rate of mercury is a result of its combination with bacterial cells and metabolites. Reagents which either oxidize or solubilize organics removed mercury most effectively from sample containers in which mercury-bearing water had been stored. A small amount of mercury was found to have diffused into the polyethylene bottles. Solute mercury was most effectively stabilized in laboratory solutions and water samples with 0.05% KMnO4 without acidification.

75:05B-027
MIGRATION OF SALT FROM FEEDLOT WASTE AS AFFECTED BY MOISTURE REGIME AND AGGREGATE SIZE,
Amoozegar-Fard, A., Fuller, W.H., Warrick, A.W.
Arizona Agricultural Experiment Station,
Journal of Environmental Quality, Vol. 4 No. 4 p 468-472, October-December 1975.
5 fig, 6 tab, 14 ref.

Descriptors: *Salinity, *Return flow, *Feed lots, Water management(applied), Water quality control, Soil moisture.

The migration of salt from three different aggregate sizes of feedlot manure under three moisture regimes was evaluated. The three sizes were small (to pass a 40-mesh sieve), medium (0.9 cm in diameter, 2.25 cm in length), and large (4.5 cm in diameter, 2.5 cm in length). The three moisture regimes were: (i) 12 hours saturation, 12 hours drainage by gravity, this step was repeated five times; (ii) 12 hours saturation, 12 hours drainage by gravity, 48 hours oven drying at 60C, also repeated five times; and (iii) continuous leaching for 60 hours at a constant rate. After each 12 hour saturation period the leachates were collected and the electrical conductivity (EC), pH, and concentrations of K, Na, Ca, Mg, NH4, NO3, Cl, S,P, and eight trace elements determined.

75:05B-028
A SIMULATION MODEL OF BIOPHYSIOCHEMICAL TRANSFORMATIONS OF NITROGEN IN TILE-DRAINED CORN BELT SOIL,
Duffy, J., Chung, C., Boast, C., Franklin, M.
National Science Foundation.
Journal of Environmental Quality, Vol. 4, No. 4, p 477-486, October-December 1975. 8 fig, 1 tab, 30 ref.

Descriptors: *Model studies, *Simulation analysis, *Nitrogen, *Corn, *Drainage, Water quality, Nitrification, Denitrification, Evapotranspiration, Crop response.

A computer simulation model of nitrogen transformations and transport in soil in a Corn Belt field was developed to predict nitrate concentrations in tile effluent as a function of farm management practices and climatic conditions. Water flow in the unsaturated and saturated zones, evapotranspiration, and nitrogen flow due to mass flow, dispersion, and diffusion are simulated along with nitrogen transformations of mineralization, immobilization, nitrification, and denitrification. Growth of corn and soybeans is included. Predicted values of tile water flow, water table height, nitrate-nitrogen concentrations in the soil water profile and in the tile effluent compared favorably to measure values for filed for 1972; also, predictions of nitrate-nitrogen concentrations in tile effluent for 1970-71 agree well with actual data.

75:05B-029
HEAT DISPOSAL IN WATER ENVIRONMENT,
Harleman, D.R.F.
Massachusettes Institute of Technology, Cambridge, Massachusettes, Laboratory for Water Resources and Hydrodynamics.
Journal of the Hydraulics Division, Vol. 101, No. HY9, p 1117-1138, September 1975. 1 fig, 21 ref, 2 append.

Descriptors: *Heated water, Heat transfer, Heating, Water pollution, Water quality.

A number of analytical and experimental techniques for predicting water temperature distributions due to waste heat discharges have been examined. Predictive techniques are needed in the preparation of environmental impact statements for preoperational site studies in order to evaluate the economic and environmental costs of alternative cooling water systems. These techniques are also useful in post-operational studies, inasmuch as field observations can be carried out only under a limited number of ambient conditions. Mathematical models can be used in interpreting field data and for providing additional information for receiving water conditions other than those measured. The use of mathematical or physical models, or both, for the planning and design of field monitoring programs has received relatively little attention. It is suggested that a considerable amount of time and expense could be saved by making use of temperature prediction models in planning field surveys.

75:05B-030
NATURAL (15)N ABUNDANCE IN SOIL, LEAVES, AND GRAIN AS INFLUENCED BY LONG TERM ADDITIONS OF FERTILIZER N AT SEVERAL RATES,
Meints, V.W., Boone, L.V., Kurtz, L.T.
Illinois University, Department of Agronomy and Illinois Agricultural Experiment Station, Urbana, IL.
Journal of Environmental Quality, Vol. 4 No. 4, p 486-490, October-December 1975. 4 Fig, 1 tab, 20 ref.

Descriptors: *Fertilization, *Fertilizers, *Nitrogen, *Corn, *Soybeans, Crop response.

Soil, leaf, and grain natural (15)N abundance was measured in corn and soybean plots which had received various rates of fertilizer N for 20 years. Soil (15)N abundance did not significantly reflect the amount of fertilizer N applied and should not be used to estimate fertilizer N additions. Corn leaf and grain (15)N abundance reflected additions of fertilizer N only at low rates of fertilizer N applied and should not be used to estimate fertilizer N additions. Corn leaf and grain (15)N abundance reflected additons of fertilizer N only at low rates of fertilizer N applied. Soybean leaf (15)N abundance reflected a decrease in symbiotic N fixation with additional increments of fertilizer N applied.

75:05B-031
RELATIONSHIPS BETWEEN SORPTION AND DESORPTION OF PHOSPHORUS BY SOILS,
Ballaux, J.C., Peaslee, D.E.
Institute of Tropical Agriculture, Ibadan, Nigeria.
Soil Science Society of America Proceedings, Vol. 39, No. 2, p 275-278, March-April 1975. 1 Fig, 7 tab, 23 ref.

Descriptors: *Sorption, *Phosphorus, *Soil properties, Soil investigations, Soil chemistry, Soils.

Relationships between the sorption and desorption of P were investigated for five soils ranging in clay content from 16 to 51%. Langmuir adsorption isotherms for some soils were curvilinear when the P concentration in the equilibrium solution was >10micro-g/ml. To evaluate sorption at higher concentrations of P, values of adsorption maxima (b) and indices of bonding energy (k) were estimated from tangents to six segments of each isotherm. Within each soil, the six pairs of b and k values were related according to the equation k=(a/b)(n), where n was a unique characteristic for each soil.

75:05B-032
SORPTION OF SULFUR DIOXIDE BY CALCAREOUS SOILS,
Yee, M.S., Bohn, H.L., Miyamoto, S.
Arizona University, Tucson, 85721
Soil Science Society of America Proceedings, Vol. 39, No. 2, p 268-270. March-April 1975. 5 Fig, 3 tab, 14 ref.

Descriptors: *Sorption, *Sulfur, *Sulfur compounds, *Calcareous soils, Soil chemistry, Soil chemical properties, Pollutants.

The capacities and rates of calcareous soils to sorb SO2 were measured by a steady-state method in which a stream of air plus SO2 passed rapidly through the soil. At room temperature, air-dry calcareous soils were saturated with SO2 within 10 to 15 min from a dry gas stream. The sorption capacities, 0.4 to 1.6 g of S/100 g of soil at 0.14% SO2 in air, increased with SO2 concentration and specific surface of the soils. Moisture in the air and/or soils increased the SO2 sorption capacities to 0.8 to 6.4 g of S/100 g, approximately equivalent to the acid-titratable basicities, but saturation required several hours. The initial sorption rate ranged from 0.06 to 0.29% S/min in the moist soils.

75:05B-033
EFFECT OF ANION EXCLUSION ON THE MOVEMENT OF CHLORIDE THROUGH SOILS,

Appelt, H., Holtzclaw, K., Pratt, P.F.
Facultad de Ciencias Quimicas, Universidad de Chile, Casilla 233, Santiago, Chile.
Soil Science Society of America Proceedings, Vol. 39, No. 2, p 264-267, March-April 1975. 2 fig, 4 tab, 14 ref.

Descriptors: *Soil chemistry, *Chlorides, *Soil chemical properties, Soil investigation, Soil properties, California, Cation exchange.

The effects of anion exclusion on the movement of chloride through soils was studied using a variety of subsurface soil samples from southern California. The data reported, suggest that the nature of the clay mineral, clay content, saturation percentage and iron oxide content together with the cation-exchange capacity are important soil characteristics related to the volume of exclusion. General equations that are based only on specific charge, seem to be oversimplifications. Another serious limitation of general equations obtained under laboratory conditions is their extrapolation to field conditions. The high variability regarding salt distribution commonly found in the field, makes the use of correction factors, such as volume of exclusion, of limited value. More studies under field conditions are necessary before quantitative predictions can be made using general equations obtained with disturbed soil samples in the laboratory.

75:05B-034
LONGITUDINAL DISPERSION IN NATURAL CHANNELS,
Day, T.J.
Geological Survey of Canada, Ottawa (Ontario).
Water Resources Research, Vol. 11, No. 6, p 909-918, December 1975. 11 fig, 5 tab, 31 ref.

Descriptors: *Dispersion, *Channel flow, Natural flow, *Tracers, *Mixing, Flow, Flow profiles, *Path of pollutants, Convection, Movement, Water pollution, Channels, On-site investigations.

The longitudinal dispersion of fluid particles in natural channels was investigated in an extensive series of experiments in small mountain streams (New Zealand). These experiments extended over a maximum distance of 2,250 m, a mean velocity range of 0.12-1.57 m/s, and a mean flow width range of 2.7-21.8 m. It was conclusively shown for these channels and others as well that the spread or standard deviation of an initially concentrated mass increases linearly with distance and not as its square root, as is necessary for the application of Taylor's mixing model. One consequence of the linearity is an ever-increasing dispersion coefficient along the channel. It was also shown that the time-concentration curve of a dispersing tracer mass maintains a persistent asymmetry. This persistent asymmetry and the continued linear spreading appeared to be characteristic of dispersion in natural channels and as such showed the inadequacies of applying Taylor's analysis.

75:05B-035
NEW TRITIUM DATA ON MOVEMENT OF GROUNDWATER IN WESTERN FRESNO COUNTY, CALIFORNIA,
Poland, J.F., Stewart, G.L.
Geological Survey, Sacramento, California.
Water Resources Research, Vol. 11, No. 5, p 716-724, October 1975, 8 fig, 2 tab, 10 ref.

Descriptors: *Water pollution sources, *Tritium, *Groundwater, *Path of pollutants, *California, Data collections, Sampling, Water wells, Nuclear explosions, Radioactivity effects, Evaluation

As a result of thermonuclear explosions that began in 1954, tritium concentrations in precipitation and streamflow in the northern hemisphere have fluctuated greatly. Well waters along two traverse lines in western Fresno County, California were sampled in 1963 and tested for tritium concentration. Haskell et al. (1966)

estimated from the apparent thermonuclear tritium concentrations that groundwater had moved westward in the lower waterbearing zone at a maximum velocity of 14-16.5 miles (23-27km) in 9 years. The maximum velocities and permeabilities estimated from the 1961 sampling were about an order of magnitude greater than the velocities and permeabilities suggested by prior hydrologic and geologic evidence. Consequently, in 1969-1970 the U.S. Geological Survey sampled and tested the tritium concentrations of well waters along the same two traverses but also extended the sampling eastward. On the basis of these analyses it is concluded that (1) thermonuclear tritium had not invaded the lower zone by 1970 within the extent of the 1961 sampling and (2) although the maximum westward movement of groundwater in the lower zone from 1955 to 1970 is indeterminate, it has been less than 4 miles (6.5 km) from the recharge area in 15 years.

75:05B-036
SOLUTE TRAVEL-TIME ESTIMATE FOR TILE-DRAINED FIELDS: II. APPLICATION TO EXPERIMENTAL STUDIES,
Jury, W.A.
California University, Riverside. Department of Soil Science and Agricultural Engineering.
Soil Science Society of America Proceedings, Vol. 39, No. 6 p 1024-1028, November-December 1975. 3 fig, 5 tab, 11 ref.

Descriptors: *Leaching, *Water quality, *Effluents, *Drainage water, *Solutes, *Path of pollutants, Pollutants, Mathematical models, Forecasting, Wastes, Fertilizers, Water pollution sources, Tiles, Drains, Excess water(Soils), Monitoring, Data collections, Legislation.

The model of Jury (1975) for estimating travel time from surface application to point of discharge for tile-drained fields was applied to data from published studies of tile-drain effluent concentrations and solute flux. In all systems the observed values were consistent with model calculations, and in circumstances where an exact comparison was possible the agreement between measured and predicted values was very good. Measures proposed for improving water quality by requiring standards for effluent discharge levels were discussed and criticized, and model simulations of projected monitoring policies of typical field systems were used to demonstrate the potential for misinterpreting the relationship between surface inputs and output levels.

75:05B-037
SOLUTE TRAVEL-TIME ESTIMATES FOR TILE-DRAINED FIELDS: I. THEORY,
Jury,W.A.
California University, Riverside. Department of Soil Science and Agricultural Engineering.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1020-1024, November-December 1975. 6 fig, 14 ref.

Descriptors: *Leaching, *Water quality, *Effluents, *Drainage water, *Solutes, *Path of pollutants, Pollutants, Mathematical models, Forecasting, Wastes, Fertilizers, Water pollution sources, Tiles, Drains, Excess water(Soils).

A model based on papers by D. Kirkham (1949, 1958) was proposed for calculating solute travel times and effluent water quality for tile-drained soil profiles for cases of ponded and unsaturated surface water input. Variables required for utilization of the model were drain spacing, depth of tile, depth to impermeable zone, soil porosity, and mean discharge rate over the time of study. By using dimensionless variables a characteristic travel-time parameter was introduced which represented a system and allowed the model calculations to be summarized on a single graph. Simulations were run for cases of miscible displacement, step-function surface solute input, and periodic surface solute input; differences between ponded and unsaturated leaching were discussed for tile systems

75:05B-038
IDENTIFICATION IN NONLINEAR, DISTRIBUTED PARAMETER WATER QUALITY MODELS,

Yih, S.M., Davidson, B.
Rutgers - The State University, New Brunswick, New Jersey. Department of Chemical and Biochemical Engineering.
Water Resources Research, Vol. 11, No. 5, p 693-704, October 1975. 9 fig, 6 tab, 47 ref.

Descriptors: *Model studies, *Water quality, *Estuarine environment, *New Jersey, Water pollution control, Estuaries, Salinity, Tides, Water pollution, *Path of pollutants, *Delaware River, Dispersion.

Systematic and efficient numerical algorithms were developed and applied to the identification of unknown functional parameters in nonlinear estuarine water quality models based on input-output measurements. As an illustration of the methodology the longitudinal dispersion coefficient was identified from an intratidal, time-varying, variable area, salinity intrusion model by using both simulated data and actual data from the Delaware River estuary. A comparison among three proposed algorithms through extensive simulation research showed that Marquardt's algorithm emerged as the most efficient one. Effects of noise content and the number of data measurement locations on parameter sensitivity were investigated. Actual monitored salinity data for 3 days in September 1965 were tested in the saline portion of the Delaware River estuary. The spatial variation of the longitudinal dispersion coefficient for this period was estimated. The results obtained indicated that the methodology is generally applicable. It represents a different and supplementary alternative to the methods based on analytical predictions and empirical correlations.

75:05B-039
NITRATE, PHOSPHORUS, AND SULFATE IN SUBSURFACE DRAINAGE WATER,
Baker, J.L., Campbell, K.L., Johnson, H.P., Hanway, J.J.
Iowa State University, Ames. Department of Agricultural Engineering.
Journal of Environmental Quality, Vol. 4, No. 3, p 406-412, July-September, 1975. 3 fig, 4 tab, 17 ref.

Descriptors: *Eutrophication, *Tile drainage, *Groundwater, *Nutrients, Nitrates, Nitrogen, Sulfates, Phosphorus, Phosphates, Subsurface drainage, Fertilization, Flow rates, Agriculture, Iowa.

To determine nutrient losses associated with subsurface drainage water and the effect fertilization rate has on these losses, measurements were made of flow, nitrate-nitrogen, phosphate-phosphorus, total phosphorus, and sulfate-sulfur in subsurface drainage water from tile-drained cropland in Iowa. Annual nutrient losses were variable; phosphorus, sulfate-sulfur, and nitrate-nitrogen losses ranged from 0 to 0.04, 0 to 12, and 0 to 91 kg/ha, respectively, and were dependent on amount of water lost. Because of low phosphorus concentrations, losses with subsurface drainage water were insignificant compared to losses associated with surface runoff. Sulfate-sulfur and nitrate-nitrogen concentrations appeared to be inversely related. Tile drainage water with consistently high nitrate-nitrogen relative to surface runoff was believed responsible for high nitrate-nitrogen contents sometimes found in rivers draining central Iowa. Nitrate from saturated and unsaturated soil indicated that water waves or pulses with different nitrate-nitrogen concentrations move through the soil causing variations in subsurface drainage water with time and flow rate. The large amounts of nitrate-nitrogen lost from some tile drains with modest fertilization and variations in tile drains make it impossible to ascribe nitrate-nitrogen loss to fertilizers alone. Nitrate-nitrogen loss represents an economic and energy waste as well as an environmental hazard.

75:05B-040
PHOSPHORUS IN SURFACE RUNOFF FROM A DECIDUOUS FOREST,
Singer, M.J., Rust, R.H.
Minnesota University, St. Paul. Department of Soil Science.
Journal of Environmental Quality, Vol. 4, No. 3, p 307-311, July-September 1975. 4 fig, 2 tab, 26 ref.

Descriptors: *Phosphorus, *Rainfall-runoff relationships, *Eutrophication, *Surface runoff, *Deciduous forests, Minnesota, Snowmelt, Forest soils, Soil erosion.

Phosphorus loss in surface runoff from a deciduous forest ecosystem was determined in Lake Minnetonka, Minnesota, watershed. Runoff was highest in March due to melting snowpack, in May due to continuous heavy rains, and in July due to intense short duration rains on dry soil. Runoff in other months was related to rainfall amount, intensity, and soil moisture. Most small storms did not precipitate runoff. Intense storms often exceeded the soil's infiltration rate, dislodged soil particles, with consequent runoff. The canopy reduced precipitation intensity and amounts reaching the soil surface. Forest litter had a large water holding capacity and rapid infiltration rate which protected soil mineral from direct rainfall impact and reduced runoff. Any melting snow in December-January saturated lower snow layers but did not create runoff. Spring runoff volume was determined by snowpack depth, water content, air temperature, and presence or absence of frozen soil surfaces. Yearly runoff volume and timing varied greatly. March runoff had more phosphorus but in other months phosphorus concentration was inversely related to runoff volume. Sediment phosphorus loss was linearly correlated with maximum precipitation. Care should be given in extrapolating the findings for the rate of phosphorus loss from the test plot to an entire forest.

75:05B-041
NITRATE MOVEMENT AND ITS DISTRIBUTION IN THE SOIL PROFILE OF DIFFERENTIALLY FERTILIZED CORN WATERSHEDS.
Schuman, G.E., McCalla, T.M., Saxton, K.E., Knox, H.T.
Agricultural Research Service, Cheyenne, Wyoming.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1192-1197, November-December 1975. 4 fig, 2 tab, 20 ref.

Descriptors: *Nitrates, *Fertilizers, *Soil profiles, *Soil-water movement, *Ion transport, *Iowa, Analytical techniques, Inorganic compounds, Leaching, Nutrient removal, Water pollution sources, Path of pollutants, Water quality, Nitrogen, Soil analysis, Irrigation effects, Soil tests, Percolation, Groundwater, Root zone, Agriculture, Loess, Contour farming, Corn(Field), Agricultural watersheds.

Nitrate movement within the 6.1-m soil profile of a watershed in southwestern Iowa, fertilized at 448 kg N/ha per yr, resulted in a 750-kg/ha increase in NO_3-N below the corn root zone during the 3-year study. The NO_3-N concentration of the baseflow from the watershed increased during this period, indicating that some of the leached NO_3-N reached the groundwater. The watershed fertilized at the recommended N rate (168 kg/ha per yr) did not increase the quantity of NO_3-N below the corn root zone; however, some NO_3-N leaching did occur. Between April 1971 and April 1974, the accumulation of NO_3-N in the profile of the excessively fertilized watershed moved from the 1.8- to 3.1-m depth. The watershed fertilized with 168 kg N/ha per yr did not show any zones of significant NO_3-N accumulation in the soil profile at any of the sampling dates. The depth to the water table on the lowest contour sampled on the excessively fertilized watershed was 4.6 and 4.9 m in April 1971, and April 1974, respectively. The average NO_3-N concentration for these two sampling dates at the water table depth increased from 3.7 to 13.9 ppm. The average NO_3-N concentration at the water table depth on the normally fertilized watershed was 2.8 and 4.5 ppm in April 1973 and April 1974, respectively, with a water table depth of 3.0 m.

75:05B-042
INFILTRATION OF ORGANIC PHOSPHATE COMPOUNDS IN SOIL.
Rolston, D.E., Rauschkolb, R.S., Hoffman, D.L.
California University, Davis. Department of Land, Air, and Water Resources.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1089-1094, November-December 1975. 6 fig, 19 ref.

Descriptors: *Infiltration, *Irrigation practices, *Soil types, *Fertilizers, *Phosphorus compounds, Leachate, Groundwater movement, Penetration, Soil properties, Phosphates, Nutrient removal, Phosphorus, Soil analysis, Evaluation, Soil chemistry, Soil bacteria, Soil moisture, Soil water, Organic compounds, Clay loam.

Organicphosphate compounds may be moved greater distances into soil than is possible with inorganic phosphates, inasmuch as organic phosphates must be enzymatically hydrolyzed to orthophosphate before soil reactions inhibit movement. The hydrolysis in solution and movement in soil of six organic phosphates were investigated in order to evaluate possible advantages of the compounds as fertilizers. The compounds studied were glycerophosphate, methyl ester phosphate, glycol phosphate, ethyl ester phosphate, glucose 1-phosphate, and glucose 6-phosphate. The infiltration of organic P compounds into Panoche clay loam soil and glycerophosphate into five soils differing in texture, clay type, organic matter, and pH and into one soil at three water contents was investigated by infiltrating organic P solution into columns of dry or moist soil at a rate of 66 kg of P/ha. Inorganic P concentration in bicarbonate extracts was measured as a function of soil depth at the termination of infiltration. The movement of P from organic compounds was compared with the movement of potassium phosphate. All the organic phosphates hydrolyzed at similar rates. The P from all the organic compounds moved to approximately the 12-cm depth in the calcareous Panoche clay loam soil with only slight differences in P concentration above that depth, whereas inorganic phosphate moved no more than 2-3 cm. The enzymatic hydrolysis rate of glycerophosphate and the resulting P distribution after infiltration was influenced by soil type.

75:05B-041
FLUOMETURON AND WATER CONTENT DISTRIBUTIONS DURING INFILTRATION: MEASURED AND CALCULATED,
Wood, A.L.; Davidson, J.M.
Oklahoma State University, Stillwater. Department of Agronomy.
Soil Science Society of America Proceedings, Vol. 39, No. 5, p 820-825, September-October 1975. 7 fig, 1 tab, 20 ref.

Descriptors: *Path of pollutants, Pollutant identification, *Adsorption, *Herbicides, *Dispersion, *Infiltration, Laboratory tests, Numerical analysis, Soil moisture.

Laboratory columns of Cobb sand were used to study the movement and distribution of surface applied 1,1-dimethyl-3-(a,a,a,-trifluoro-m-tolyl) urea (fluometuron) for three infiltration rates and two initial soil-water contents. Fluometuron movement showed little dependence on initial soil-water content for a given infiltration rate. Experimental data indicated that equilibrium existed between the adsorbed and solution phases for all infiltration rates and initial soil-water contents studied with the exception of the ponded infiltration into airdry soil case. A simultaneous numerical solution of the water and solute transport equation described a fluometuron pulse, for large infiltration rates, which lagged the experimental data. The agreement between calculated and measured distributions was improved when the infiltration rate was reduced. The shape of the fluometuron pulse was reasonably well described by the mathematical model.

75:05B-044
NITROGEN MOVEMENT IN A SHALLOW AQUIFER SYSTEM OF THE NORTH CAROLINA COASTAL PLAIN,
Daniels, R.B.; Gilliam, J.W.; Gamble, E.E.; Skaggs, R.W.
Soil Conservation Service, Raleigh, North Carolina.
Water Resources Bulletin, Vol. 11, No. 6, p 1121-1130, December 1975. 4 fig, 1 tab, 3 ref.

Descriptors: *Nitrogen, Movement, *Aquifers, *Coastal plains, Water pollution, Waste water disposal, *North Carolina, *Path of pollutants, Aquicludes, Groundwater, Porous media, Water table aquifers, Nitrates, Ammonium salts, Nitrites, Chemical wastes, Water pollution sources, Flow, Migration, Waste disposal, Waste storage, Industrial wastes, Groundwater movement.

Concentrations of ammonium- and nitrate-nitrogen of about 10,000 ppm moved from an untreated surface storage pond into the groundwater in the sandy beds of the surficial sediments in northeastern North Carolina. This high concentration of nitrogen moved through the permeable sandy beds with the groundwater above the Yorktown Formation aquiclude to the Chowan River with only minor dispersion normal to the hydraulic gradient. There was essentially no nitrogen movement into the Yorktown aquiclude even though solutions of 2,000 ppm (soil basis) had been in the overlying sediments for 2 to 3 years. The possibility of the nitrogen moving into the deeper aquifers used for community water supplies is very small. Only the shallow groundwater above the Yorktown Formation in the immediate area will be contaminated with nitrogen because there is little lateral dispersion away from the flow of groundwater toward the Chowan River.

75:05B-045
COMPARISON OF THERMAL SCANNING AND IN SITU TECHNIQUES FOR MONITORING THERMAL DISCHARGES,
Marmer, G.J., Tokar, J.V., Madding, R.P.
Argonne National Lab., Illinois.
Water Resources Bulletin, Vol. 11, No. 6, p 1157-1180, December 1975. 15 fig, 3 ref.

Descriptors: *Remote sensing, *Infrared radiation, *Thermal pollution, *Heated water, *Path of pollutants, Nuclear powerplants, Great Lakes, *Lake Michigan, *Isotherms, Aircraft, Temperature, Water cooling, Water pollution sources, Water temperature, Lakes.

Two methods of measuring the behavior of thermal plumes were compared by application to plumes at Point Beach Nuclear Power Plant on Lake Michigan. The classical in situ method, which employs surface and subsurface thermistor probes extended from a boat whose position is determined by a microwave ranging system, was contrasted with a remote sensing technique which utilizes an aircraft-mounted infrared scanner operating in the 8-14 micron range. Principal characteristics of plume description were isothermal configurations, areas contained within isotherms, and centerline temperature decay. The in situ method was slow and subject to effects of external forces over the test period, and it required interpolative judgment to generate isotherms; but it did provide information on subsurface as well as surface temperatures. Thermal scanning produced a considerably more detailed picture of surface temperature but it was subject to distortion by surface skin effects during extremely calm conditions. Good agreement between the methods was found in four of five occasions; the fifth instance was a case of quiescent conditions distorting the results of thermal scanning. It was proposed that the methods be used jointly to achieve the best possible picture of thermal plume behavior.

75:05B-046
SUSPENDED SEDIMENT AND TURBIDITY IN IRRIGATION RETURN FLOWS - A PROTOTYPE STUDY,
Hobson, R., Autry, B., McGuire, R.
Soil Conservation Service, Spokane, Washington.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, December 15-18, 1975, Chicago, Illinois. 12 p, 2 fig.

Descriptors: *Suspended solids, *Suspended load, Sediment discharge, Sediment load, Sediment yield, Turbidity, Surface irrigation.

Field measurements of inflow and outflows quantity and quality (suspended sediments and turbidity) were taken from five farm units. Canals, wasteways, and sediment basins were similarly measured. The results provide prototype baseline relationships of the effects of surface irrigation on these two parameters.

75:05B-047
CHLORIDE CONTAMINATION IN ALUM CREEK, CENTRAL OHIO,
Pettyjohn, W.A.
Ohio State University, Columbus. Department of Geology and Mineralogy.
Ground Water, Vol. 13, No. 4, p 332-339, July-August 1975. 8 fig, 7 ref.

Descriptors: *Water pollution, *Chlorides, *Brines, *Ohio, Brine disposal, Oil fields, Injection wells, Wastes, Pollutants, Surface waters, Groundwater, Water pollution sources, *Path of pollutants, Seepage, Soil contamination, Water quality, Taste, Discharge(Water), Sampling, Water analysis.

Periodically, Alum Creek at the Westerville water treatment plant contains excessive concentrations of chloride, producing a salty taste. The chloride is not removed during the water treatment process. Uncontaminated surface water and groundwater throughout Alum Creek basin contain less than 25 mg/l of chloride. Larger concentrations are related to man's activity in the basin, particularly oil production. The chloride content in samples of contaminated surface water ranged from 26 to nearly 26,000 mg/l, while samples from oil-field brine pits ranged between 1,000 and 57,000 mg/l. Even a brief examination of the data indicates that most of the chloride contamination in Alum Creek is due to: (1) the discharge of oil-field brines directly into the mainstem or its tributaries in the upper reaches of the basin, or (2) the discharge of contaminated groundwater into streams. In many areas, the highly mineralized groundwater that is now seeping into the streams may have been contaminated a decade ago.

75:05B-048
ASSESSING UNRECORDED ORGANIC POLLUTION FROM AGRICULTURAL, URBAN, AND WOODED LANDS,
Yu, S.L., Whipple, W. Jr., Hunter, J.V.
Rutgers--The State University, New Brunswick, N.J.
Water Research, Vol. 9, No. 10, p 849-852, October 1975. 5 fig, 4 tab, 9 ref.

Descriptors: *Biochemical oxygen demand, *Water pollution, *Organic wastes, *Water pollution sources, *Regression analysis, *New Jersey, Streamflow, Frequency analysis, Watersheds(Basins), Runoff, Sampling, Analysis.

An investigation was conducted of the organic pollution for seven small New Jersey watersheds representing agricultural, urban, and wooded lands. The 5-day biochemical oxygen demand (BOD) was used as a main index of organic pollution. Data obtained for 2.5 yr period indicated background BOD concentrations averaging from 1.5 to 3.0 mg/l in all streams, except that a value of 9.0 mg/l was obtained for a residential-commercial-industrial area. During or after rainstorms, the BOD loadings, in pounds per day per unit area, usually became more than ten times the background amount for all streams. No significant correlation was found between BOD concentration and flow rate, but good correlations were obtained between BOD loadings and flows. The seasonal pattern of BOD loading distribution was examined. The frequency distribution of BOD concentrations and loadings were also obtained.

75:05B-049
A SUMMARY OF THE BIOGEOCHEMISTRY OF NITROGEN COMPOUNDS IN GROUND WATER,
Behnke, J.
California State University, Chico.
Journal of Hydrology, Vol. 27, No. 1/2, p 155-167, October 1975. 4 fig, 1 tab, 55 ref.

Descriptors: *Nitrogen compounds, *Nitrates, *Water quality, *Groundwater, *Nitrogen cycle, *Biochemistry, Ammonia, Nitrites, Fertilizers, Inorganic compounds, Nitrogen, Monitoring, Measurement, Data collections, Agricultural chemicals, Surface runoff, Water chemistry, Water pollution, Path of pollutants, Water pollution sources.

The biogeochemistry of nitrogen compounds in groundwater is exceedingly complex. The exclusive chemical monitoring of nitrates in groundwaters is overly simplistic and may lead to errors in data interpretation. Nitrogen compounds are biodegradable, and an understanding of the physical, chemical, and biologic systems through which transient water is moving is important in analyzing chemical data. Groundwater nitrate contamination is generally encountered in shallow aquifers which have direct or indirect hydraulic continuity with the ground surface. Surface sources of groundwater nitrate contamination related to man's activities include domestic sewage, agricultural practices, and high-density animal confinement.

75:05B-050
VERSATILE MULTIRANGE ANALYTICAL MANIFOLD FOR AUTOMATED ANALYSIS OF NITRATE-NITROGEN,
Jackson, W.A., Frost, C.E., Hildreth, D.M.
United States Department of Agriculture, Agricultural Research Service, Watkinsville, GA 30677.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 592-593, May-June 1975. 2 fig, 1 tab, 9 ref.

Descriptors: *Nitrates, *Nitrogen, Nutrients, Laboratory equipment, Laboratory tests, Soil chemistry.

This note describes a technique for extending up to 100 ppm the limits of determining nitrate-nitrogen in solution using a Technicon AutoAnalyzer system. The same modified analytical manifold can be used to determine three concentration ranges of nitrate nitrogen 0-1, 0-10, and 0-100 ppm. To change concentration range, change the sample entry point in the manifold and standardize the instrument within the proper range.

75:05B-051
SUBSURFACE BIOLOGICAL ACTIVITY IN RELATION TO GROUND-WATER POLLUTION,
McNabb, J.F., Dunlap, W.J.
Subsurface Environmental Branch, Robert S. Kerr Environmental Research Laboratory, U.S. Environmental Protection Agency, P.O. Box 1198, Ada, Oklahoma 74820.
Ground Water, Vol. 13, No. 1, p 33-44, January-February 1975. 62 ref.

Biological activity occurring in subsurface regions below the soil zone may be of considerable importance in determining the fate and effect of pollutants in ground water, but this possibility has received little previous attention. This paper comprises a discussion of subsurface biological activity in regard to ground-water pollution as reflected by available literature references. The subsurface environment is discussed in terms of factors likely to be of greatest significance in regard to the development of biological systems, and previous investigations of subsurface microbial activity are reviewed. Available information indicates the presence in the upper continental crust of the earth of numerous regions, particularly those of sedimentary origin, which are probably suitable habitats for many microbial species. Previous investigations of subsurface microbial activity clearly show the presence of diverse microbial populations in many subsurface regions below the soil zone. Hence, microbial activity appears both possible and probable in most subsurface regions of importance in regard to ground water. Further elucidation of the extent and nature of microbial activity in subsurface regions is needed in developing methods for predicting the impact on ground-water quality of pollutants released into the earth's crust.

75:05B-052
DEVELOPMENT OF FRESH GROUND WATER NEAR SALT WATER IN WEST VIRGINIA,
Wilmoth, B.M.
United States Environmental Protection Agency, 303 Methodist Building, Wheeling, West Virginia 26003.
Ground Water, Vol. 13, No. 1, p 25-32, January-February 1975. 3 fig, 1 tab, 7 ref.

Descriptors: *Saline water, *Saline water intrusion, West Virginia, Groundwater, Water quality, Water pollution.

Salt-water migration into relatively shallow rocks in the western half of West Virginia is already rather far advanced. Because of the wide distribution of salty ground water and connate brine at various depths, it is difficult to determine how much of the contamination is natural and how much is the result of subsurface industrial activities. Although some local salt-water problems are the result of oil and gas operations, much of the regional near-surface salt water is a natural condition unrelated to deep drilling or other industrial activities.

75:05B-053
ON RADIOACTIVE WASTE MANAGEMENT: AN ANALYSIS OF THE PARAMETERS CONTROLLING SUBSURFACE CONTAMINANT TRANSFER,

Schwartz, F.W.
Department of Geology, Alberta University, Edmonton, Alta. (Canada).
Journal of Hydrology, Vol. 27, p 51-71, 1975. 9 fig, 12 equ, 15 ref.

Descriptors: *Radioactivity, *Radioactivity effects, *Model studies, Soil water movement.

The problem of subsurface, radioactive-contaminant transfer is investigated theoretically through the development of a two-dimensional model which considers the simultaneous flow of water and mass. In addition to the well-known physical transport processes, convection and dispersion, the model treats radioactive decay and cation exchange which are two of the most important concentration attenuation processes. The influence of factors, which control the transport processes, on subsurface contaminant distributions is demonstrated through the simulation and analysis of a series of hypothetical cases. With respect to the physical transport processes, hydraulic conductivity, porous medium dispersivity and the location of the contaminant inflow zone are considered as controlling parameters.

75:05B-054
NITRATE REDUCTION BY DENITRIFYING BACTERIA IN SINGLE AND TWO STAGE CONTINUOUS FLOW REACTORS,
Dodd, D.J.R., Bone, D.H.
Department of Chemical Engineering, Queen's University, Kingston, Ontario, Canada.
Water Research, Vol. 9, No. 3, p 323-328, March 1975. 6 fig, 1 tab, 5 equ, 18 ref.

Descriptors: *Denitrification, *Nitrate, *Bacteria, Chemical reactions.

Denitrification by a mixed bacterial population of medium was studied in batch, a single stage continuous flow stirred reactor (CFSTR) and a two stage CFSTR at 30 degrees C. The optimum pH for denitrification, nitratase, nitrite reductase activities and growth was found to be 7.5 in batch culture.

75:05B-055
NITRIFICATION IN RIVERS IN THE TRENT BASIN,
Curtis, E.J., Durrant, K., Harman, M.M.
Water Research Centre (Stevenage Laboratory), England.
Water Research Vol. 9, No. 3, p 255-268, March 1975. 6 fig, 1 equ, 11 tab, 15 ref.

Descriptors: *Nitrification, *Bacteria, Sediments, Chemical reactions.

The presence of autotrophic nitrifying bacteria in the waters and sediments of both the River Trent and its polluted tributary the River Tame was established and their concentrations determined. Nitrification was shown to occur mainly in the sediments, where it was estimated that at least 80 per cent of the oxidation of ammonia occurred.

75:05B-056
DENITRIFICATION WITH A BACTERIAL DISC UNIT,
Davies, T.R., and Pretorius, W.A.
National Institute for Water Research of the Council for Scientific and Industrial Research, P.O. Box 395, Pretoria, South Africa.
Water Research, Vol. 9, No. 3, p 459-463, March 1975. 5 fig, 12 ref.

Descriptors: *Denitrification, *Bacteria, Anaerobic conditions, Anaerobic bacteria, Chemical reactions.

An enclosed rotating disc unit was operated anaerobically as a denitrifying system, with methanol as the hydrogen donor. The C:N ratio necessary for complete denitrification was found to be 2.6:1. Optimum pH for denitrification lay in the range between pH 7.0 and 8.0. Q sub 10 values were 1.38 between 18 and 30 C, 7.66 above 30 C and 13.06 below 18 C.

75:05B-057
WATER POLLUTION FROM NONPOINT SOURCES,
McElroy, A.D., Chiu, S.Y., Nebgen, J.W., Aleti, A., Vandegrift, A.E.
Midwest Research Institute, Kansas City, Missouri 64110.
Water Research Vol. 9, No. 7, July 1975. p 675-681, 3 tab, 18 ref.

Descriptors: *Water quality, Water quality control, Return flow, Agriculture, Mining.

The goals of water quality management have shifted profoundly in recent times from protection of public health to several, and often conflicting, beneficial uses of receiving waters. Resource protection has become an object of public policy. It is essential that nonpoint as well as point sources of pollutants be controlled to achieve current objectives of water quality management. The aim of this study was to assess the nature and extent of nonpoint source pollution in the United States from four major industrial activities: agriculture, silviculture, mining, and construction.

75:05B-058
NATURAL SOIL NITRATE: THE CAUSE OF THE NITRATE CONTAMINATION OF GROUND WATER IN RUNNELS COUNTY, TEXAS,
Kreitler, C.W., Jones, D.C.
Bureau of Economic Geology, The Texas University, Austin, Texas 78712.
Ground Water, Vol. 13, No. 1, p 53-61, January-February, 1975. 11 fig, 1 tab, 13 ref.

Descriptors: *Nitrate, *Texas, Groundwater, Water quality, Water pollution, Soils, Soil investigations.

The ground waters of Runnels County, Texas, are highly contaminated with nitrate. The average nitrate concentration of 230 water samples was 250 mg/l NO_3. The natural variations of the stable nitrogen isotopes N14 and N15 identified natural soil nitrate as the predominant source. Nitrate from animal wastes was of minor importance. Dryland farming since 1900 has caused the oxidation of the organic nitrogen in the soil to nitrate. Minimal fertilizer has been used because of the lack of suitable water for irrigation. During the period 1900-1950, nitrate was leached below the root zone but not to the water table. Extensive terracing after the drought in the early 1950's has raised the water table approximately 6 meters and has leached the nitrate into the ground water. Tritium dates indicate that the ground water is less than 20 years old.

75:05B-059
LOSSES OF DIURON, LINURON, FENAC, AND TRIFLURALIN IN SURFACE DRAINAGE WATER,
Willis, G.H., Rogers, R.L., Southwick, L.M.
United States Department of Agriculture, Southern Region, Louisiana Agriculture Experiment Station, Baton Rouge , LA.
Journal of Environmental Quality, Vol. 4, No. 3, 1975. p 399-402, 5 tab, 27 ref.

Descriptors: *Return flow, *Runoff, *Herbicides, Water pollution, Water quality, Pollution, Aquatic environment, Aquatic life, Drainage water.

Diuron, linuron, fenac, and trifluralin were applied to plots designed for sampling surface runoff. Over a 3-year period, highest concentrations in runoff were usually associated with rainstorms that occurred soon after application. Maximum seasonal losses were less than 0.12, 0.30, 2.90, and 0.05% of the applied diuron, linuron, fenac, and trifluralin, respectively. The data suggest that with proper use on agricultural land in the lower Mississippi River Valley these herbicides pose little threat to adjacent aquatic areas.

75:05B-060
NITROGEN LOSSES FROM SOILS OF THE NORTH CAROLINA COASTAL PLAIN,
Gambrell, R.P., Gilliam, J.W., Weed, S.B.
North Carolina Agricultural Experimental Station, Raleigh, NC. North Carolina University.

Journal of Environmental Quality, Vol. 4, No. 3, 1975. p 317-323.

Descriptors: *Nitrogen, *Denitrification, *Nutrients, Soils, Soil investigations, Drainage, Drainage effects, Fertilizers, Fertilization, North Carolina, Return Flow, Sediments, Corn.

Nitrogen balances were measured for a moderately well-drained and a poorly drained soil in the North Carolina Coastal Plain to evaluate the effect of drainage on the fate of unutilized fertilizer N. Approximately one-half of the fertilizer N applied to each soil was not utilized by the crop. Most of the nitrogen lost by surface runoff from both soils was organic nitrogen associated with the sediment. However, there was a measurable increase in loss of nitrogen from fertilized plots as compared to unfertilized plots. The poorly drained soil (27% organic matter) had approximately 70% less surface runoff than did the moderately well-drained soil (3% organci matter). However, the concentration of N in runoff from the poorly drained soil was almost twice as great resulting in nearly identical N losses from the two soils. Much of the total surface loss of N from corn occurred during the first few months after planting.

75:05B-061
POLLUTION OF SURFACE IRRIGATION WATERS BY PLANT PATHOGENIC ORGANISMS,
Steadman, J.R., Maier, C.R., Schwartz, H.F., Kerr, E.D.
Nebraska University, Lincoln, Nebraska 68503.
Water Resources Bulletin, Vol. 11, No. 4, p 796-804, August 1975. 3 fig, 3 tab, 20 ref.

Descriptors: *Pollution, Water quality, Irrigation, Irrigaiton water, Surface irrigation, Pathology, Return flow.

Systematic sampling of waterways and irrigation runoff from agricultural lands in the North Platte Project of Nebraska in July and August of 1972-1974 demonstrated that phytopathogenic organisms were disseminated. The organisms monitored included the bean common blight bacterium, the bean white mold fungus and various nematodes. Although many types of nematodes often were recovered from irrigation water, Heterodera sp. cysts which cause significant disease problems in the valley were found infrequently. Patterns of movement of the bacterial and fungal organisms were correlated with previous or current season infection of bean plants.

Section XXII

WATER QUALITY MANAGEMENT AND PROTECTION

EFFECTS OF POLLUTION (GROUP 05C)

75:05C-001
REGIONAL SEWERING AND GROUNDWATER QUALITY IN THE SOUTHERN SAN JOAQUIN VALLEY.
Schmidt, K.D.
Water Resources Bulletin, Vol. 11, No. 3, p 514-525, June 1975. 4 fig, 9 ref.

Descriptors: *Soil disposal fields, *Sewage effluents, *Sewage treatment, *Sewage disposal, Groundwater, Groundwater movement.

Sewage effluent is commonly disposed of on land in arid regions, and the majority usually recharges the groundwater. Few evaluations have been made of the effect of effluent disposal on groundwater quality in the west. Groundwater hydrologists are rarely involved with treatment plant design and operation or effluent disposal in the San Joaquin Valley, California. The author's purpose is to evaluate the effect of regional sewering programs on groundwater quality in this valley. Research was conducted on past studies of sewage effluent disposal. An extensive water sampling program was undertaken near the Fresno Sewage Treatment Plant. Chloride contents were used to trace recharged effluent. The extent of recharged effluent was delineated and traced for about ten miles. Sampling between the plant and the urban Fresno area indicated a high probability of large-scale leakage of raw sewage into groundwater.

75:05C-002
A SIX-YEAR WATER, PHOSPHORUS, AND NITROGEN BUDGET FOR SHAGAWA LAKE, MINNESOTA.
Malueg, K.W., Larsen, D.P., Schults, D.W., Mercier, H.T.
United States Environmental Protection Agency, Corvallis.
Journal of Environmental Quality, Vol. 4, No. 2, p 236-242, April-June 1975.
11 fig, 5 tab, 11 ref.

Descriptors: *Phosphorus, *Nitrogen, *Water pollution, *Water pollution effects, Eutrophication, Hydrologic budget, Nutrients, Waste water, Minnesota.

Water, phosphorus, and nitrogen budgets of eutrophic Shagawa Lake, Minnesota were determined from 1967-1972 to assist in defining the significance of the loading from the city of Ely secondary waste water treatment plant to the trophic state of the lake. Ely's municipal waste water accounted for about 80% of the P, 24% of the N, and only 2% of the water to Shagawa Lake while the major tributary, Burntside River, accounted for 65% of the water, 42% of the N, and only 11% of the P to the lake. An average of 30% of the P was retained within the lake. The water and nutrient budgets, along with field and laboratory studies, indicated that high levels of P from the municipal waste water treatment plant were mainly responsible for the eutrophic condition of Shagawa Lake.

75:05C-003
THE RESPONSES OF SOILS AND SOIL MICROORGANISMS TO SILVER IODIDE WEATHER MODIFICATION AGENTS.
Sokol, R.A., Klein, D.A.
Colorado State University, Fort Collins, Department of Microbiology.
Journal of Environmental Quality, Vol. 4, No. 2, p 211-214, April-June, 1975.
4 fig, 18 ref.

Descriptors: *Soil chemistry, *Soil microorganisms, *Cloud seeding, *Organic matter, *Silver iodide, Microbial degradation, Soil environment.

To determine the consequences of AgI weather modification agent accumulation to the soil microbial environment, the effects of added silver compounds to microbial growth, anaerobic cellulose degradation, and the soil environment adjacent to a cloud seeding generator were investigated. Silver ion inhibited microbial growth in culturals at low concentrations and cultures saturated with AgI displayed an inhibition of growth initiation. An analysis of the soil surrounding a seeding generator site in Steamboat Springs, Colorado indicated that deposited silver tends to remain near the soil surface. Alterations in the soil environment due to high silver concentrations were indicated by consistently higher organic matter levels, water contents, microbial populations and rates of soil respiration. These results suggest that high concentrations of seeding agent potentially can alter the soil microbial environment by inhibiting organic matter decomposition, but that the silver levels which accumulate in seeded target areas should have no overt effects on the soil environment.

75:05C-004
EUTROPHICATION OF MICROPONDS,
Batchelder, A.R.
United States Department of Agriculture, Western Region Agricultural Research Service and Colorado Agricultural Experimental Station.
Journal of Environmental Quality, Vol. 4, No. 4, p 520-526, October-December 1975. 3 Fig, 6 tab, 14 ref.

Descriptors: *Eutrophication, *Algae, *Nutrients, Water quality, Soil investigations.

Three soils having different chemical and physical properties were flooded with deionized water and used as bottom soils for greenhouse microponds. The submerged soils supplied sufficient nutrients to the overlying water to sustain algal growth for 489 days in two successive floodings of 219 and 270 days each. Differences in electrical conductivity, pH, and nutrient concentration were observed among the three soils and a control nutrient solution. During the first flooding, indigenous algae prevailed in the soil systems, but during the second flooding the dominant algal genera were less diversified.

75:05C-005
SOLUBLE SALTS AND NITRATE DISTRIBUTION IN IRRIGATED LETTUCE BEDS,
Husmadi, R.H., Fangmeir, D.D., Tucker, T.C.
Arizona University, Tucson, Department of Soils.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 4, p 686-689, July-August 1975. 5 Fig, 2 tab, 9 ref.

Descriptors: *Irrigation, *Irrigation effects, *Salinity, *Saline soils, *Lettuce, Nitrate, Sprinkler irrigation, Furrow irrigation, Irrigation practices.

The salt and nitrate content was measured in lettuce beds irrigated by sprinkler, furrow between beds. Furrow irrigation continually increased the salt content of the surface 2.5 cm of soil in the bed particularly in the center of the bed. Sprinkler irrigation slightly decreased the salt content during the season. Below 7.5 cm the irrigation method had little effect.

75:05C-006
INTERACTION BETWEEN AQUATIC PLANTS AND BED SEDIMENTS IN MERCURY UPTAKE FROM FLOWING WATER,
Mortimer, D.C., Kudo, A.
Ottawa River Project, Joint study by National Research Council of Canada Laboratories and Ottawa University.
The Journal of Environmental Quality, Vol. 4, No. 4, p 491-495, October-December 1975. 8 Fig, 4 tab, 8 ref.

Descriptors: *Mercury, *Aquatic environment, *Aquatic life, *Aquatic plants, Aquatic soils.

Bed sediment from a known zone in the Ottawa River study area and cuttings of Elodea densa were set out in aquaria in a 24-day controlled, flowing water experiment. Elodea was planted in sediment and in glass beads, and sediment was exposed with and without plants, all in the same aquaria for 7 days before the addition of mercuric chloride were continuously metered into the input water to yield aquarium levels of 0,1,2, and 10 micro-g/liter. There was no signigicant difference in the uptake rate between the two forms of mercury. Uptake was proportional to water concentration over the entire 17-day exposure period in both plants and sediment. Methyl mercury was more toxic to plant growth in this time interval than inorganic mercury.

75:05C-007

INVESTIGATION AND REHABILITATION OF A BRINE-CONTAMINATED AQUIFER,

Fryberger, J.S.
Engineering Enterprises, Inc., P.O. Box 5, Norman, Oklahoma 73069.
Ground Water, Vol. 13, No. 2, p 155-160, March-April 1975. 4 fig, 1 tab, 7 ref.

Descriptors: *Aquifers, *Groundwater, *Brine disposal, Arkansas, Water quality, Pollution, Water pollution.

Faulty disposal of oil field brine through an "evaporation" pit and later through a faulty disposal well resulted in the contamination of one square mile of an alluvial aquifer in southwestern Arkansas. The physical parameters of the contamination are defined, and some of the chemical changes that occur as the brine moves through the aquifer are explained. In addition, alternate methods of aquifer rehabilitation are explored, and the costs of rehabilitation are compared with potential benefits. It is concluded that rehabilitation is not now economically justified.

75:05C-008

COMBINED EFFECTS OF LOW OXYGEN AND SALINITY ON GERMINATION OF A SEMI-DWARF MEXICAN WHEAT,

Aceves-N., E., Stolzy, L.H., Mehuys, G.R.
Colegio de Postgraduados, Escuela Nacional de Agricultura, Chapingo, Mexico.
Agronomy Journal, Vol. 67, No. 4, p 530-532, July-August 1975. 4 fig, 1 tab, 7 ref.

Descriptors: *Oxygen, *Oxygen requirements, *Wheat, Crop response, Salinity, Soil salinity, Germination, Seeds.

The simultaneous occurrence of low oxygen and high salinity conditions is common in a wide range of irrigated soils. The combined effects of O2 and osmotic potential stresses on germination of wheat were tested under growth chamber conditions. A range of O2 concentrations and salinity levels were chosen to simulate soil aeration and salinity combinations that might be expected to occur in well-aerated, fine-textured, saline, and saline-sodic soils. Daily observations of number of seeds germinated and days to first germination were recorded.

Section XXIII

WATER QUALITY MANAGEMENT AND PROTECTION

WASTE TREATMENT PROCESSES (GROUP 05D)

75:05D-001
BIOLOGICAL DENITRIFICATION AND ITS' APPLICATION IN TREATMENT OF HIGH-NITRATE WASTE WATER,
Francis, C.W., Callahan, M.W.
Oak Ridge National Laboratory, Oak Ridge, TN
Journal of Environmental Quality, Vol. 4 No. 2, p 153-163, April-June 1975.
2 fig, 1 tab, 62 ref.

Descriptors: *Nitrate, *Nitrite, *Nitrogen, *Waste water, *Waste water treatment, *Denitrification, Waste water disposal, Fertilizers.

One method of removing nitrate nitrogen from waste water effluents appears to be biological denitrification. Considerable research regarding denitrification of municipal and agricultural waste water containing relatively low concentrations of nitrate has been conducted. However, very little research has been carried out on the feasibility of applying the process to waste water effluents which contain in excess of 1,000 ppm NO(3)-N. Waste water effluents containing this magnitude of nitrates are generated in fertilizer and explosive manufacturing operations. Large quantities of nitrates are also expected to be produced at future nuclear fuel processing and uranium oxide fuel fabrication plants. This review comprehensively evaluates the various requirements for biological denitrification in respect to NO(3)-N concentrations as well as quantity and type of carbon substrate and complementary cations. It also assesses which engineering design, e.g., modified activated sludge units, packed-bed reactors, or anaerobic columns, may be most applicable in biological denitrification of waste streams containing concentrations greater than 1,000 ppm NO(3)-N.

Section XXIV

WATER QUALITY MANAGEMENT AND PROTECTION

ULTIMATE DISPOSAL OF WASTES (GROUP 05E)

75:05E-001
OUTLOOK FOR THE FUTURE OF DEEP WELL DISPOSAL,
Conrad, E.T., Hipson, H.E.
Water Resources Bulletin, Vol. 11, No. 2, p 370-378, April 1975. 1 fig, 4 tab, 6 ref.

Descriptors: *Wells, *Waste disposal, *Waste disposal wells, Wastes, Groundwater.

This paper presents a rationale for estimating the quantities of industrial waste that may be disposed of by deep well injection. For the purpose of this discussion, deep well injection refers to disposal to a saline aquifer (not a potable water supply) and does not include injection of oil field brine. Literature discussing regulation and curtailment of deep well injection of industrial wastes presents the argument that little is known about this method, which is true to an extent. Industrial wastes have been disposed of by deep well injection for which only 162 are currently operating. However, related experience has been deep wells now being utilized for this purpose.

75:05E-002
DO HEAVY METALS PREVENT THE AGRICULTURAL USE OF MUNICIPAL SLUDGE,
Jorgensen, S.E.
Royal Danish School of Pharmacy, Copenhagen.
Water Research, Vol. 9, p 163-170, 1975. 11 fig, 5 tab, 16 ref.

Descriptors: *Heavy metals, *Agriculture, *Sludge disposal, Groundwater, *Soil disposal fields, Soil treatment, Soil-water-plant relationships, Humus.

The chemical binding of heavy metals on different samples of soil was found. The pollution of heavy metals in soils by use of sewage sludge can be controlled by maintaining the pH at 7.0 or more and applying sludge preferably on soil with a high content of humus and clay. More than 300 tons of municipal sewage sludge can be applied per acre total, e.g. 20 tons per year over a 10 year period, without any danger. In most cases, lead is the metal limiting the amount of sludge that can be used due to its possible contamination of ground water.

75:05E-003
EFFLUENT FOR IRRIGATION - A NEED FOR CAUTION?,
Walker, W.H.
Illinois State Water Survey, Urbana, Illinois 61801.
Ground Water, Vol. 13, No. 1, p 11-15, January-February 1975. 24 ref.

Descriptors: *Water quality, *Water quality control, Water pollution, Return flow, Irrigation, Irrigation practices, Sewage, Sewage effluents, Sewage treatment.

Existing pollution protection laws prohibit surface-water dilution of effluents and sludges. Drying, burning, or distilling them is very costly, causes air pollution, and produces potentially hazardous chemical residues which still must be disposed of in some nonpolluting fashion. There are no "technologically feasible, economically reasonable" alternative methods of effectively treating these wastes to an acceptable quality level for discharge to streams. For these reasons, land disposal of sewage effluent and sludges now is being widely promoted and employed as the best available method of treatment. Most operating facilities for land disposal of effluents are not monitored adequately to provide required data to quantitatively evaluate the total buildup and possible subsequent release of toxic chemicals in contiguous soil, plant, and water environments. Considering the potential danger to public health which may result if widespread use of this particular waste disposal practice is employed, it is imperative that all such permitted sites be monitored and evaluated in detail for all possible adverse effects, and the results of these findings then considered in the design and operation of future installations, if minimal pollution from this practice is to be assured in the future. Concurrent with this work, research must be expedited and greatly expanded to develop effective alternative treatment methods to employ where land disposal of effluent proves to be impracticable.

Section XXV

WATER QUALITY MANAGEMENT AND PROTECTION

WATER TREATMENT AND DISTRIBUTION (GROUP 05F)

75:05F-001
PRECIPITATION OF PHOSPHATE FROM SOLUTION USING ALUMINUM SALT,
Hsu, P.H.
Cook College, Rutgers University, The State University of New Jersey, New Brunswick, New Jersey 08903. Department of Soils and Crops.
Water Research, Vol. 9, No. 12, p 1155-1161, December 1975. 8 fig, 5 tab, 1 equ, 18 ref.

Descriptors: *Phosphate, *Chemical precipitation, Water quality, Waste water, Waste water treatment.

In the absence of any interfering component, the optimum pH range and the effectiveness of aluminum phosphate precipitation were found to vary with the initial ratio of phosphate to aluminum in sample preparation. Phosphate was almost completely removed from solution when aluminum was in large excess. At maximum, 1 mole of phosphate was precipitated by 1 mole of aluminum, but this occurred only when phosphate was in large excess.

Section XXVI

WATER QUALITY MANAGEMENT AND PROTECTION

WATER QUALITY CONTROL (GROUP 05G)

75:05G-001
OBJECTIVES OF WATER QUALITY PLANNING,
Krause, R.D.
Kansas Water Resources Board, Topeka.
Journal of the Hydraulics Division, Proceedings of American Society of Civil Engineers, Vol. 101, No. HY3, Paper No. 11200, p 471-476, March 1975.

Descriptors: *Water resources, *Planning, *Water quality control, Hydraulics, Decision making, Land use, Natural resources, Conservation, Irrigation, Education, Public health, Environment.

Planning is a useless effort if it does not produce a viable procedure for reaching its objectives. Our political process is presently atuned to crisis reaction, producting short-range decisions and simplistic solutions to problems which often serve to confuse and delay the adoptions of hard viable solutions. The control of water quality is noble objective in itself; however, the need for it is symptomatic of a much deeper and profound disease that must be cured or prevented before a completely successful water quality control program can be achieved. The disease is that of 'living beyond our resource means'. To overcome this, the nation objectives should be to: (1) minimize natural resource waste; (2) protect the public health and ecosystem; (3) provide for a system of control that has a practical probability of being achieved; and (4) provide for a positive decision-making process that leads to the rapid consumation of the objectives previously stated.

75:05G-002
GROUND-WATER'S ROLE IN WATER QUALITY MANAGEMENT,
Osgood, J.O.
Pennsylvania Department of Environmental Resources, Harrisburg. Bureau of Water Quality Management.
Journal of the Hydraulics Division, Proceedings of the American Society of Agricultural Engineers, Vol. 101, No. HY3, P 517-521, March 1975.

Descriptors: *Groundwater, *Water quality contol, State jurisdiction, Water management (Applied), Surface waters, Water pollution, Hydrogeology, *Pennsylvania, Administration, Water quality standards.

Federal legislation requires each state to protect the quality of its surface waters, yet this protection is stated only indirectly for subsurface waters. Because surface waters/groundwater evaluation must be integrated in water quality monitoring, the state of Pennsylvania was one of the first to design a Comprehensive Water Quality Management Plan (COWAMP) to protect groundwater as a vital resource. Over two-thirds of that state's public water supply and 90% of its private water supplies are dependent upon groundwater. The slow migration of contaminated surface water has been demonstrated to cause groundwater pollution. Examples of this are landfill leachate, leaking industrial water impoundments, gasoline spills flushed to the soil, improperly developed spray irrigation sites, and urban runoff infiltration. The COWAMP plan considers groundwater in its role as a major water supply, including new developments in well construction. Groundwater is also seen as a transporting medium for contaminant dispersion; for example gasoline spills move on top of the water table and fumes may migrate up through the soil into buildings as it flows. Additionally, activities affecting the recharge/discharge balance influence waste water treatment and related costs. COWAMP hopes to identify existing hydrogeological characteristics, to study man's impact on existing resources, and to evaluate alternatives. This involves considering areas of poor water quality, areas requiring special protection, such as recharge zones, important watersheds, large population centers, and areas where major population growth is predicted.

75:050-001
SALINITY CONTROL AND FEDERAL WATER QUALITY ACT.
Bessler, M.B., Maletic, J.T.
Bureau of Reclamation, Denver, Colorado. Water Quality Office.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 101, No. HY5, Proceeding paper No. 11321, p 581-594, May 1975. 6 fig, 1 tab, 17 ref.

Descriptors: *Salinity, *Water quality control, *Colorado River, *Water management (Applied), Water resources development, *Comprehensive planning, Standards, Economic impact, Evaluation, River basins, Simulation analysis, Computer models, Constraints, Mathematical models, Systems analysis, Federal jurisdiction, Southwest U.S.

Salinity as a mineral pollutatnt is receiving increased attention in the Western U.S. in terms of economic impacts. The salinity control problem on the Colorado River is examined in relation to the Federal Water Quality Act, PL 92-500. Even basin-wide slainity controls as presently envisioned will not be able to meet anticipated salinity standards and the 'zero discharge' goals of the Act. Described is the Colorado River Water Quality Improvement Program (CRWQIP), only one element of an entire matrix of management plans in theColorado River Basin. CRWQIP has five categories of control under present study: river system management; point source control; diffuse source control; irrigation source control; and return flow utilization. Options that may be required for the present nondegradation policy are: minimize deep percolation losses from irrigation; desalt return flow and divert brine stream from the system; desalt water prior to select use; divert and reuse saline flows for nonagricultural use; and combinations of foregoing. Discussed is the use of the Colorado River Simulation Model. A new planning strategy of total water management is suggested to identify and evaluate water needs, water resources, physical technology, management technology, and other nonphysical constraints. Thus, specific economic limitations and institutional constraints identified under the various management options will assist in setting attainable salinity levels within a river basin in lieu of meeting rigid zero discharge limitations for each user. Systems analysis tools are advocated for comprehensive basinwide management.

75:050-004
HYDROGEOLOGY AND WATER QUALITY MANAGEMENT.
Landon, R.A.
Moody and Associates, Incorporated, Harrisburg, Pennsylvania. Environmental Services Division.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 101, No. HY2, Proceedings paper 11137, p 255-269, February 1975.

Descriptors: *Management, *Hydrogeology, *Water quality, Aquifer management, Environmental effects, Land use, Topography, Soils, Geology, Geochemistry, Surface-groundwater relationships, Groundwater movement, Discharge (Water), Model studies, Methodology, Geologic mapping, Maps, *Pennsylvania, Hydraulics.

Numerous environmental and water quality investigations were completed which are largely two-dimensional in that the environmental and land-use factors were evaluated from a surficial standpoint only, with minimum concern given to the third dimension of depth, and therefore, the majority of the hydrogeologic framework lying below land surface. An integral part of Comprehensive Water Quality Management Planning (COWAMP) program for Pennsylvania is a definition of the hydrogeologic framework that controls the occurrence of ground water, as well as data describing the quantity and quality of that resource. Recognition of the fact that the environment is a complex interweaving of many variables, and the strong control exerted by the natural physical components comprising the hydrogeologic framework can be expected to minimize or avoid the deleterious and sometimes catastrophic results of the omission of such recognition.

75:050-005
LEGAL PERSPECTIVE ON WATER QUALITY MANAGEMENT,
Bissey, D.R.
Department of Environmental Resources, Commonwealth of Pennsylvania, Harrisburg, PA
Journal of the Hydraulics Division, Vol. 101, No. HY5, p 595-601, May 1975. 13 ref.

Descriptors: *Legal aspects, *Water quality control, Water quality, Water quality standards, Water resources development, Pennsylvania.

It has become increasingly obvious that wastewater treatment requirements and water supply are critical determinates of growth patterns. If we run a costly interceptor through prime farm land, it is likely that urbanization of one sort or another will follow. If stream discharge standards are set sufficiently high to protect the fragile ecosystems of first and second-order streams, development in those watersheds will be discouraged. If we make water allocations based upon an uncritical acceptance of growth projections we may not only jeopardize interrelated water quality objections but may also irreparably upset stable environmental relationships in the donor or recipient area. Water quality planning should not just be sewer planning for narrow public health and water quality goals. It should analyze all the complex elements of our dependance upon water and should recommend a management system consistent with the long-term survival of human life and the natural surroundings which we cherish.

75:050-006
WATER RIGHTS AND WATER QUALITY MANAGEMENT,
Walker, W.R., Cox, W.E.
Virginia Water Resources Research Center, Blacksburg, VA.
Journal of the Hydraulics Division, Vol. 101, No. HY3, p 511-518, March 1975.
17 ref.

Descriptors: *Water rights, *Water quality control, *Institutional constraints, Institutions.

It appears that the basic institutional weaknesses of water rights make them unsuitable as a primary water quality management device. The comparative advantages of the administrative agency approach are such that few would seriously question its desirability. Yet water rights still function in an important supplemental capacity. Although there are substantial obstacles to successful legal action in connection with the violation of such rights, successful suits are brought and the deterrent effect with regard to other polluters serves to assist administrative efforts. Also of continuing importance is the function of judicially enforced water rights in relieving inequities between individual parties. Even if a management program achieves water quality goals such that the general public interest is being served, it is possible that localized problems still could exist. The courts are the ideal institution in this situation for applying the principles of private rights and distributing the losses resulting from water quality alteration between the parties involved in accordance with some concept of social justice.

75:050-007
A NOTE ON COST-EFFECTIVENESS IN DATA ACQUISITION IN WATER QUALITY MANAGEMENT,
Nielsen, K.S., Friborg, H., and Rundgaard-Nielsen, M.
Vandkvalitetsinstitut, Soborg(Denmark).
Water Resources Research, Vol. 11, No. 2, p 357-358, April 1975, 2 fig, 1 ref.

Descriptors: *Water quality, *Management, *Sampling, *Costs, Equations, Effluents, Monitoring, River basins, Optimization, Constraints, Algorithms, Systems analysis, Mathematical models.

An iterative procedure for sampling in water quality management is presented. The procedure, which utilizes constrainted mixed integer programming, establishes a relationship between cost of sampling and relative uncertainty in total discharge into the water sytem and at the same time provides an optimal frequency matrix for sampling. The frequency of sampling at each discharge is treated as an independent variable.

75:050-008
MODELS OF LAND AND WATER ALLOCATION TO IMPROVE ENVIRONMENT AND WATER QUALITY THROUGH SOIL LOSS CONTROLS,
Heady, E.O., Nicol, K.J.
Iowa State University, Ames. Center for Agricultural and Rural Development; and Iowa State University, Ames. Department of Economics.
Water Resources Research, Vol. 11, No. 6, p 795-800, December 1975. 4 fig, 5 tab, 8 equ, 3 ref.

Descriptors: *Water quality control, *Environment, *Water allocation(Policy), Land resources, Agriculture, United States, Water supply, Crops, Livestock, Technology, Evaluation, Economic impact, Optimization, Constraints, Equations, Mathematical models, Systems analysis.

A soil loss, land-water allocation optimization model has been developed that is applicable to all agricultural land in the United States. The model includes 223 producing areas, 1891 land resource areas, and 51 water supply regions. Different cropping systems and technologies are defined for each crop and livestock system in each of the 1891 land resource regions. The programming model is thus of very large scale, including also a transportation submodel and market regions. As a means of water quality improvement, limits are placed in the per acre per year soil loss as a means of reducing sedimentation and the transport of nitrogen and phosphates into streams. A nitrogen balance equation limits fertilizer purchases and forces utilization of livestock wastes in the region. The model forces a land use system and set of technologies over the country and interregionally having soil loss unrestricted, at 10 tons per acre, at 5 tons per acre, and at 3 tons per acre. The unrestricted and 5-ton limits are reviewed in this paper in relation to impacts on soil loss (reduced about 25%), crop distribution, technology, water use, and farm prices.

75:051-009
RECLAMATION OF SOILS CONTAMINATED WITH RADIOACTIVE STRONTIUM,
Lagerwerff, J.V., Kemper, W.D.
Agricultural Research Service, Beltsville, Maryland.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1077-1080, November-December 1975. 3 fig, 3 tab, 13 ref.

Descriptors: *Land reclamation, *Strontium radioisotopes, *Leaching, *Radioactivity, *Soil contamination, Reclamation, Fallout, Radiochemical analysis, Environmental effects, Leachate, Radioactivity techniques, Chemical analysis, Analytical techniques, Soil management, Gypsum, Dispersion, Tracking techniques, Pollutants, Pollution abatement, Colorado, Soil treatment.

Evesboro loamy sand, Sassafras sandy loam, and Fort Collins silt loam were treated with a mixed Ca-Sr solution to give about 95% saturation with Ca and 5% saturation with Sr. Samples of these soils were place in acrylic cylinders and leached with 0.05N CaCl2 to remove Sr. The leachings were mechanically controlled at various rates for different periods of time. Extracting the leached soil samples with 1N HCl yielded residual Sr equal to 0.4%, 0.6%, and 0% of the Sr exchange capacity of the Evesboro, Sassafras, and Fort Collins soils, respectively. There was general agreement between Sr concentrations measured at various depths and those calculated on the basis of the Lapidus-Amundson equation, especially so with heavier soils. The Evesboro and Fort Collins soils were also tagged with carrier-free Sr85 and, mounted in columns, leached with 0.05N solutions of either CaCl2 or SrCl2. The removal of Sr85 was more complete from the Evesboro than from the Fort Collins soil, and from the center than from the edge of the columns. Short-term leaching capability of SrCl2 exceeded that of CaCl2 where Sr85 was present in amounts small enough to be adsorbed mostly on specific soil adsorption sites. Where larger amounts of Sr85 had been adsorbed, Ca was equally effective as Sr in replacing the contaminant.

75:050-010
SALINITY POLICY FOR COLORADO RIVER BASIN,
Skogerboe, G.V.; Walker, W.R.
Colorado State University, Fort Collins. Department of Agricultural Engineering.
Journal of Civil Engineers, Vol. 101, No. HY8, p 1067-1075, August, 1975. 1 fig, 13 ref.

Descriptors: *Salinity, *Colorado River, *Water policy, *Water quality control, *Water law, Water pollution, Saline water, Salts, Irrigation water, Desalination, Colorado River Basin, Colorado River Compact, Mexican Water Treaty, Water resources, Mexico, Water supply, Impaired water quality, Costs, Arizona, California, Water management(Applied).

Increasing salinity concentrations in the Colorado River are threatening the utility of water resources in the downstream areas of Arizona, California, and the Republic of Mexico. The U.S. Environmental Protection Agency reports that existing damages to lower basin users would increase from $16,000,000 annually in 1970 to $51,000,000 annually by the turn of the century if planned developments do not include appropriate salinity control measure. A brief description of the most important salinity control measures is given along with a short summary of the Colorado River Compact, the Upper Colorado River Compact, and the Mexican Water Treaty. The water quality goal for the Colorado River to maintaining salinity concentrations in the lower stem at or below present levels would be better than setting numerical standards. This policy should be applied to each state by offsetting salinity detriments resulting from each new development with salinity control measures that will maintain a net salt balance leaving state boundaries.

75:050-011
GEOCHEMICAL FACTORS AFFECTING ARTIFICIAL GROUNDWATER RECHARGE IN THE UNSATURATED ZONE,
Wood, W.W., Signor, D.C.
Geological Survey, Lubbock, Texas.
Transactions of the ASAE, Vol. 18, No. 4, p 677-683, July-August 1975. 11 fig, 1 tab, 14 ref.

Descriptors: *Geochemistry, *Artificial recharge, *Groundwater, *Chemcontrol, Chemical analysis, Recharge, Texas, New Mexico, Ion exchange, Anion exchange, Cation exchange, Hydrogen ion concentration, Adsorption, Hydrology.

Recent research on artificial groundwater recharge has focused on spatial-temporal aspects. The type and magnitude of chemical controls at a site are studied. Chemical considerations are placed into two categories: the change in geometry of the interstitial pore space and the prediction of the quality of the water with time. The observations discussed fall into the second category. The recharge facility used, a 9.4-ha basin near Lubbock, Texas, is typical of the Southern High Plains of Texas and New Mexico, and the water was imported from Lake Meredith, near Amarillo. Porous ceramic cups were used to collect water samples at depths of 0.6, 2, 8, 16, 23, and 33 meters, first daily and then weekly. Chemical analyses were performed for pH, bicarbonate and specific conductance. Chloride concentration increased with depth. Ion exchange was one of the most important chemical processes observed in the system. Cation and anion exchange took place, but cation exchange dominated. This could be an important consideration in a predictive model, depending on whether or not the water is intended for human consumption. Some sulfate adsorption takes place and the effects are still being studied. Desorption of silica was the other major mechanism that affected the water quality. Sulfate reduction signaled a hydrologic change but the effect was small because of the rapid loss of hydraulic conductivity. Some mineral solution occurred but also had a very small effect. Studies should be conducted at other sites on the Southern High Plains of Texas and New Mexico, including more detailed analyses. With enough pertinent data incorporated into a model, accurate predictions can be made on water quality changes.

75:050-012
VARIATION OF SUSPENDED SEDIMENT LOAD IN THE PALOUSE REGION OF THE NORTHWEST,

McCool, D.K., Papendick, R.I.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, December 15-18, 1975, Chicago, Illinois. 20 p, 4 fig, 5 tab, 11 ref.

Descriptors: *Suspended load, *Suspended solids, *Sediment yield, *Sediment load, *Sampling, Water quality, Return flow, Water quality control, Water pollution.

Sediment concentrations in the Palouse small-grain dryland region of the Northwest are extremely variable on a daily, seasonal, and annual basis. Runoff events of from one to a few days in length can account for large percentages of the annual sediment discharge, and the sediment transport of a given year can be as large as the total of 4 or 5 other years. Sampling programs based on weekly samples, even at stations with excellent streamflow records, can give extremely misleading results. Sampling programs of 1 or 2 years' duration can also give extremely misleading results. If money and personnel constraints dictate a low-frequency short-duration sampling program, then it is essential that some typical portion of the study area be monitored with a high-frequency longer-duration sampling program to assess the results and for adjustment purposes.

75:050-013
WATER QUALITY CONTROL THROUGH SINGLE CROP AGRICULTURAL, NO. 4,
Lundberg, E.R., Trihey, F.T.
Bemidji State College, Minnesota. Center for Environmental Studies.
Available from the National Technical Information Service, Springfield, Va 22161, Environmental Protection Agency, Report EPA-660/2-75-026, June 1975. 114 p, 6 fig, 24 tab, 37 ref, 2 append.

Descriptors: *Farm wastes, Nitrogen, Peat, Rice, Nutrients, Phosphorus, Water quality control, Surface waters, Crops response, Consumptive use, Bioassay, Minnesota, Agriculture.

A study was conducted to determine effects on water quality from flooded paddies used for the commercial culture of wild rice, Zizania aquatica. Water samples were taken from flooded impoundments of fertilized peat and mineral soils as well as unfertilized peat soils. Weekly changes in the chemical and physical parameters of water entering, within, and discharged from paddies were measured through the summer. No significant changes were observed in the receiving water until fall draindown occurred when increases in dissolved solids, total Kjeldahl-nitrogen and total phosphorus occurred in the Clearwater River. Algal assay tests indicated that the increase in nutrients released from rice paddies were not significantly greater than would be expected in normal runoff in the area and much less than the amounts released from most agricultural endeavors. Consumptive water use was 20-22 inches per acre (51-56 cm/ha).

75:050-014
AN ECONOMIC INVESTIGATION OF TAX POLICIES FOR CONTROLLING EFFLUENT DISCHARGE,
Sassone, P.G., Ferrer, T.A.
Georgia Institute of Technology, Atlanta. Industrial Management.
Journal of Environmental Management, Vol. 3, p 43-57, 1975. 4 fig, 15 ref.

Descriptors: *Pollution taxes(Charges), *Resource allocation, *Industrial wastes, Pollution abatement, Behavior, Industries, Economics.

It is generally assumed that effluent charges will not result in efficient resource allocation because of uncertainties facing firms and political constraints. This study investigates when, and under what conditions, an effluent charge is likely to improve resource allocation. A mathematical analysis demonstrates an effluent charge can work in some instances. For the two (or few) firm separable case, certain specific psychological conjectures must characterize each firm's feeling about his adversary's potential response. As long as each firm feels that its adversary's reaction will be less intense than an eye-for-an-eye, an effluent charge will work. This study further shows an effluent taker case. Retaliation is not a viable strategy in the many-firm milieu. Since determining conjectures is nearly impossible, reservations are expressed regarding the recommendation for only an effluent charge policy in the few-firm situation. A good environmental policy might be a dual system composed of effluent charges for effluent-taking firms coupled with regulation (the current overall policy) for effluent oligopolists. Such a policy would eliminate the uncertainty which characterizes the oligopolistic situation and allow the advantages of effluent charges to improve the effluent-takers' market.

75:05G-015
PROSPECTS OF HYDROMETRY IN THE LIGHT OF MODERN TECHNOLOGY,
Framji, K.K.
International Commission on Irrigation and Drainage, p 20-38, January 1975.
44 ref.

Descriptors: *Hydrometry, *Measurement, Technology, Water quality, Water quality control, Water measurement.

The prospects from the use of modern technology that is, the application of modern sciences and the use of modern tools and materials are clearly bright for the development of precise methods and instruments of hydrometry. Sciences and technologies, such as computer-science electronics, ultrasonic and telemetry, the use of light-weight plastics and special non-ferrous alloys, the application of especially-designed hydrometric ships and aluminium and fibreglass boats, all point to future prospects of achieving high degrees of precision and uniformity in measurements. Also in the not too distant future the use of space craft and earth satellites for automatic transmission of automatically observed data is no longer in the realm of fantasy. The sky is the limit.

75:05G-016
CONTROL OF WATER POLLUTION FROM CROPLAND VOLUME I-A MANUAL FOR GUIDELINE DEVELOPMENT,
Stewart, B.A., Woolhiser, D.A., Wischmeier, W.H., Caro, J.H., Frere, M.H.
Agricultural Research Service, U.S. Department of Agriculture, Washington, D.C.
Prepared as a joint publication of Office of Research and Development, EPA, and Agricultural Research Service, USDA. July 1975. 40 fig, 21 tab,

Descriptors: *Return flow, Sediments, Nutrients, Pesticides, Crop production, Agriculture, Pollution, Water quality.

Engineering and agronomic techniques to control sediment, nutrient, and pesticide losses from cropland were identified, described, and evaluated. Methodology was developed to enable a user to identify the potential sources of pollutants, select a list of appropriate demonstrated controls, and perform economic analyses for final selection of controls. The information is presented in the form of regional maps, decision flow charts, tables, and brief technical highlights.

75:05G-017
NATURAL METHODS OF PURIFYING WASTE WATERS AND UTILISING THEM IN AGRICULTURE, BIBLIOGRAPHY, PARTS 1 & 2,
L'vovich, A.I. (Editor)
U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire.
Draft Translation 505, December 1975. 110 p.

Descriptors: *Wastewater, *Agriculture, *Water supply, Irrigation, Sewage treatment.

This bibliography gives a list of Russian published material on agricultural utilisation of waste waters and natural methods of purifying them on agricultural and municipal irrigation fields. Materials on questions of self purification of the soil from pollutants and sanitary and hygenic evaluations of soil methods are presented as completely as possible. The bibliography was updated in 1971 to contain a total of 2,200 title.

75:05G-018
A SYSTEMATIC PROCEDURE FOR TAXING AGRICULTURAL POLLUTION SOURCES,
Walker, W.R.
Colorado State University, Fort Collins, Colorado 80523. Agricultural Engineering Department.
Engineering Mechanics Section, Civil & Environmental Technology Program, National Science Foundation, Washington, D.C. 20550. October 1975, 95 p, 12 tab, 22 fig, 13 ref.

Descriptors: *Model studies, *Agriculture, *Pollution, *Colorado River Basin, *Taxes, Tax rates, Salinity.

A methodology for taxing diffuse agricultural pollution sources is presented which is based upon deriving linkages between three economic and hydrologic modeling systems. The procedure involves modeling the hydro-quality system in the agricultural area in order to identify the specific processes causing water quality degradation. Then, these results are linked through a pollution coefficient to an economic externalities model describing the detriments incurred by downstream uses of water with poor quality characteristics. And finally, an input-output model is developed from which input coefficients and business multipliers are calculated as a means of assessing the local economic impact of alternative taxing policies. The Grand Valley in Western Colorado is taken as the case study for this project since it is one of the more significant sources of salinity in the Colorado River Basin. The analysis evaluates the potential for taxing agricultural croplands in the valley as a means of controlling salinity related damages in the lower Colorado River Basin. Four groups of taxing strategies are investigated: (1) directly attributable detriments, (2) per acre equivalent salt loading, (3) salinity or pollution coefficients, and (4) values of gross revenue per acre. A discussion of how each tax could be applied is presented.

75:05G-019
AGRICULTURE AND CLEAN WATER (PROCEEDINGS OF A CONFERENCE ON AGRICULTURAL WATER POLLUTION CONTROL),
Chappelow, C.C. Jr. (Editor)
Midwest Research Institute, 425 Volker Boulevard, Kansas City, Missouri 64110.
Proceedings of a Conference held on April 3, 1975, in Kansas City, Missouri.

Descriptors: *Return flow, *Agriculture, *Pollution, Sediments, Erosion, Fertilizers, Nutrients, Livestock, Water quality, Water quality control.

A 1-day conference was held to promote a constructive dialogue on the development of plans for the control of agriculture related nonpoint source pollution arising from sediment erosion, fertilizer runoff, livestock wastes and pesticide residues. The morning session was devoted to an analysis of the state of the art on nonpoint source pollution related to agriculture with presentations on: (1) regional aspects and viewpoints; (2) agricultural pollution control; (3) technical basis of control; (4) conservation districts; (5) soil conservation; and (6) plant nutrients. The luncheon session was concerned with an economic overview, consisting of an address on economic problems and opportunities of pollution control. The afternoon session was designed to explore elements of control strategy planning for nonpoint pollution from agricultural sources with papers on: (1) the states' role; (2) one state's approach; and (3) the role of the farmer and agribusiness. The afternoon session was concluded with a panel discussion on the development of a practicable agricultural pollution control plan. Over 175 individuals from 20 different states representing local, state, regional, and federal agricultural and environmental agencies attended the conference. Also, included in the 75 different organizations represented at the conference were attendees from farmer associations, educational institutions, and agribusiness.

75:05G-020
ANNOTATED BIBLIOGRAPHY ON TRICKLE IRRIGATION,
Smith S.W., Walker, W.R.
Colorado State University, Fort Collins, Colorado. Agricultural Engineering Department, Environmental Resources Center.
Information Series No. 16, June 1975. 61 p.
(See 75:03F-039)

75:05G-021
THE DETERMINATION OF CADMIUM, LEAD, COPPER AND ZINC IN GROUND WATER, ESTUARINE SEWAGE AND SEWAGE EFFLUENT BY ANODIC STRIPPING VOLTAMMETRY,
Gardiner, J., Stiff, M.J.
Water Research Centre, Stevenage Laboratory, Elder Way, Stevenage, Herts, England.
Water Research Vol. 9, No. 5/6, p 517-523, May-June 1975. 1 Fig, 1 equ, 8 tab, 23 ref.

Descriptors: *Water quality, *Water quality control, *Trace elements, *Cadmium, Lead, Copper, Water pollution.

Anodic stripping voltammetry (ASV) using the thin-film mercury electrode was shown to be a successful technique for the determination of total (free plus complexed) trace metal concentrations in various types of aqueous sample. The method developed involved the minimum of sample treatment and required only simple and inexpensive equipment. The practical limit of sensitivity was about 0.1 micro-g/l for cadmium, lead and copper. The determination of zinc was found to be complicated by the formation of an intermetallic compound with copper. Interference by other trace metals and by complexing agents was investigated. Photochemical oxidation for the decomposition of complexes of the metals with organic ligands in filtered sewage and sewage effluent was found to be successful, although the process is slower for cadmium than for the other metals. Good agreement with atomic absorption spectroscopy was obtained for all the types of aqueous sample investigated. Possible improvements of the ASV technique are discussed.

75:05G-022
DETERMINATION OF CHLORIDE IN WATER WITH A HgS/Hg2Cl2 ELECTRODE,
Sekerka, I., Lechner, J.F., Wales, R.
Canada Centre for Inland Waters, Burlington, Ontario, Canada.
Water Research Vol. 9, No. 7, p 663-665, July 1975. 1 Fig, 4 tab, 13 ref.

Descriptors: *Chloride, *Water quality, *Water quality control, Waste water, Electrodes, Laboratory equipment.

The application of a new type of solid state chloride ion sensitive electrode, based on HgS/Hg2Cl2 has been investigated for manual and automated measurements of chloride in natural, industrial and waste water. The electrode displays Nerstian response for the range 0.05-3,500 ppm of chloride and can be used for concentrations down to 0.05 ppm (5 x 10 to the minus 7th power M). Achieved values of standard deviation, recovery and comparative tests from a variety of water samples are highly satisfactory. Inherent simplicity and sensitivity together with obtained results demonstrate the usefulness of the proposed method in routine analyses.

75:05G-023
EFFECT OF SURFACE APPLIED SULFURIC ACID ON WATER PENETRATION INTO DRY CALCAREOUS AND SODIC SOILS,
Yahia, T.A., Miyamoto, S., Stroehlein, J.L.
Arizona Univ., Tucson, Dept. of Soils, Water and Engineering.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1201-1204, November-December 1975. 3 Fig, 4 tab, 8 ref.

Descriptors: *Soil treatment, *Calcareous soils, *Revegetation, *Infiltration, Penetration, Sulfur compounds, *Southwest U.S., Gypsum, Dispersion, Percolation, Soils, Calcium carbonate, Surface waters, Vegetation regrowth, Range management, Chemical wastes, Irrigation practices, Chemicals, Physical properties, Soil amendments, Acids, Alkaline soils, Reclamation, Soil structure, Soil moisture.

Sulfuric acid, a surplus by-product of copper smelters in the Southwest, was studied to determine a possible role in reclamation and revegetation of calcareous and sodic range soils. The rate of water penetration into dry calcareous soils was measured in columns as well as boxes after concentrated (93%) sulfuric acid was applied to the soil surfaces. The rate of penetration increased with increasing acid application rates, but then decreased, with optimum application rates ranging from 5 to 15 metric tons/ha. Acid was especially effective in increasing the rate of penetration into sodium-affected calcareous soils. When acid was applied as a band on the soil surface, the wetting front advanced in an elongated semicircular form with depth. Surface applied acid was more effective than surface applied gypsum in increasing water penetration into sodium-saturated soils. Sulfuric acid may be useful for increasing water penetration into and subsequently aiding in revegetation of sodium-affected soils of semi-arid regions.

75:05G-024
A GENERAL LINEAR APPROACH TO STREAM QUALITY MODELING,
Arbabi, M., Elzinga, J.
IBM Corporation, Gaithersburg, Maryland 20760.
Water Resources Research Vol. 11, No. 2, p 191-196, April 1975. 3 tab, 14 ref.

Descriptors: *Dissolved oxygen, Water quality, Water quality control, Water pollution, Model studies, Optimization.

The problem of meeting stream dissolved oxygen standards while optimizing some objective is treated. New properties of the oxygen sag equation allow the constraint set of such mathematical programs to be described to a high degree of accuracy by linear inequalities; except for upper and lower bounds on pollutant discharges, three linear constraints at most are required per reach. Constraint elimination techniques are developed that can further reduce the number of constraints necessary. As a means of highlighting the potential power of these techniques to large-scale models they are applied to two well-known examples from the literature.

75:05G-025
COMPARISON OF METHODS FOR THE DETERMINATIONOF TOTAL PHOSPHORUS IN WATERS CONTAINING PARTICULATE MATERIAL,
O'Connor, P.W., Syers, J.K.
Grants from the Ministry of Agriculture and Fisheries, and The Department of Scientific and Industrial Research, New Zealand.
Journal of Environmental Quality, Vol. 4, No. 3, 1975. p 347-350, 4 tab, 18 ref.

Descriptors: *Phosphorus, Water quality, Water quality control, Water sampling, Sediments.

Perchloric acid digestion compared favorably with Na2CO3 fusion for the determination of total P in a range of waters containing varying concentrations of both P and particulate material. The recovery of particulate P by persulfate digestion tended to decrease with increasing particulate material concentration in both natural unfiltered samples and in filtered samples to which particulate material was added. Recovery of added soil particulate P by persulfate digestion also decreased with increasing particle size. Low recovery of P by persulfate digestion was caused by the incomplete extraction of P occluded within oxides and hydrous oxides of iron. Between 58 and 85% of the P not recovered by persulfate digestion was in the inorganic form. Persulfate digestion is not recommended for the determination of total P in waters containing particulate inorganic materials of soil origin. Perchloric acid digestion is considered to be a more suitable method for such samples.

75:05G-026
WILLINGNESS TO PAY AS A BEHAVIOURAL CRITERION FOR ENVIRONMENTAL DECISION-MAKING,
Fischer, D.W.
Waterloo University, (Ontario), Dept. of Man-Environment Studies.
Journal of Environmental Management, Vol. 3, No. 1, p 29-41, 1975. 1 fig, 39 ref.

Descriptors: *Environment, *Decision making, *Social aspects, Social values, Methodology, Attitudes, Economics, Behavior, Market value, Pricing, Surveys, Pollution taxes(Charges).

The economic nature of environmental quality questions and the inherent problems in the use of willingness-to-pay as a behavioral criterion for environmental managers is summarized. Development of an adequate theory or structure of social value which incorporates a variety of variables is necessary before attempting to apply economic techniques to environmental quality decisions, since environmental quality levels have little to do with market transactions or exchanges. Willingness-to-pay studies suffer from a lack of adequate information. Environmental damages are often perceived to be less than actually exist; and, in some cases, are concealed. Economic incentives for displaying, distorting, or hiding information are also important considerations, as is people's perceptions of their role in society. Willingness-to-pay evaluations ignore those who are not directly involved and those of future generations, both of which groups may have a strong demand for high environmental quality. Problems in determining actual individual preferences, and in the use of prices are also considered. The use of surveys in willingness-to-pay analysis are subject to the disparity between what people say and what they mean.

75:05G-027
MODELS IN WATER QUALITY PLANNING,
Abendt, R.W.
Institut fur Siedlungswasserwirtschaft, Universitat Karlsruhe, Karlsruhe (Federal Republic of Germany)
Ecological Modelling, Vol. 1, No. 3, p 205-217, September 1975. 7 fig, 2 equ, 11 ref.

Descriptors: *Model studies, *Mathematical modeling, Water quality, Decision making, Water quality control, Planning.

This paper is to show the range of applicability of water quality models. It is intended to clarify the purpose of modelling with respect to the exactness of results and to investigate problems of data collection. The data quantity and objective of modelling influence the model structure, i.e., the mathematical complexity. Two principal errors are investigated: first, the error caused by the mathematical abstractions of the natural processes in a model, and on a subsequent level, the wrong parameter estimates in a model. Furthermore, the difference between a deterministic descriptive, and a statistical approach, is discussed. In both model types, input and objectives are the same. But the methodology is fundamentally different. A practical example is presented based on a two-parameter water quality model. It is the Neckar River quality model, the limits and practicability of which are discussed in this context.

75:05G-028
MATHEMATICAL MODELLING AND ENVIRONMENTAL DECISION-MAKING,
Biswas, A.K.
Environmental Systems Branch, Department of Environment, Ottawa, Ontario. (Canada)
Ecological Modelling, Vol. 1, No. 1, p 31-48, May 1975. 1 fig, 15 ref.

Descriptors: *Mathematical modeling, *Model studies, *Decision-making, Water resources, Environment, Environmental engineering.

The primary role of a decision-maker is to make right decisions on the basis of available information and within the allowable time and resources constraints. The two basic types of models used for decision-making, technocratic and incremental, are discussed, and so are the common criteria of the decision-making process in a real world. The intensity and diversity of demands on our limited water resources have increased to such an extent that decision-makers are finding it increasingly difficult to consistently attain the needed flexibility and dexterity. Thus, even though decision-making has become exceedingly complex at present, and will become more so in the future, it is apparent that the average decision-maker has been provided with few, if any, new tools and concepts in the past several decades. One of these very few techniques in systems analysis.

Section XXVII

WATER RESOURCES PLANNING

TECHNIQUES OF PLANNING (GROUP 06A)

75:06A-001
A SCREENING MODEL FOR WATER RESOURCES PLANNING,
Viessman, W. Jr.; Lewis, G.L.; Yomtovian, I.; Viessman, J.J.
Nebraska University, Lincoln. Water Resources Research Institute
Water Resources Bulletin, Vol. 11, No. 2, p 245-255, April 1975. 2 fig, 3 tab,
7 ref.

Descriptors: Water resources, *Planning, *Linear programming, *Economic efficiency, *Simulation analysis, *Flood Control, Optimization, Regional development, Management, Streamflow, Costs, Benefits, Flood damage, Alternative planning, Surface waters, Water utilization, Reservoir storage, Recreation, Constraints, Evaluation, Hydrologic aspects, Mathematical models, Systems analysis, *Nebraska.

Optimization and simulation are combined in a procedure to select the most efficient arrangement of components for regional water resources development and management policy. The technique is applied to the Elkhorn River basin in Nebraska, which extends over 7,000 square miles and includes 184 proposed reservoirs. Structure sizes, locations and operating policies are selected for optimal plans based on economic efficiency and regional development. Model input consists of an historical or simulated sequence of unregulated annual and within-year period streamflows at each water use or management site. The proposed model is intended as a preliminary screening tool; it is easy to apply, has minimal data requirements, and has a sound physical base. Use of the model, which utilizes linear programming, in decision making for flood control is considered in detail. Objectives employed in evaluating alternatives include both net annual benefit maximization and annual cost minimization. Results indicate that substantial savings in time and costs over conventional planning techniques are effected. Agreement between model output and agency design values was noted.

Section XXVIII

WATER RESOURCES PLANNING

COST ALLOCATION, COST SHARING, PRICING/REPAYMENT (GROUP 06C)

75:06C-001
AN IMPLICIT APPROACH TO PRICING AGRICULTURAL WATER TRANSFERS TO URBAN USES.
Walker, W.R., Skogerboe, G.V.
Colorado State University, Agricultural Engineering Department, Fort Collins, Colorado 80523.
Water Resources Bulletin, Vol. 11, No. 4, p 751-758, August 1975. 6 Fig, 6 ref.

Descriptors: *Model studies, Mathematical modeling, Optimization, Urbanization, Water quality, Water transfer, Water shortage, Water quality standards.

The increased agricultural efficiency of the American farmer has been a substantial impetus to this nation's rapid urbanization. In many western regions where total water supplies are limited, urbanization has required the transfer of heretofore agricultural water rights to the urban use. A major problem in such transfers has been the value or price of the water. A management level model of a typical urban water system was developed to optimize water supply, distribution, and wastewater treatment alternatives. The values of agricultural transfers were determined as the cost advantages of increasing allowable reuse levels of urban effluents which imply the use of a downstream right. This procedure is justified by the economic theory of alternative cost. Results for a test application to the Denver, Colorado area indicate values on the order of $1,000 per acre-foot of transferable water depending on effluent water quality restrictions and operational policies.

Section XXIX

WATER RESOURCES PLANNING

WATER LAW AND INSTITUTIONS (GROUP 06E)

75:06E-001
A FRAMEWORK FOR EVALUATING INSTITUTIONAL AND SOCIO-ECONOMIC ISSUES OF LAND TREATMENT OF WASTE WATER,
Christensen, L.A.
Economic Research Service, United States Deaprtment of Agriculture, Upper Darby, PA 19082
Journal of Environmental Quality, Vol. 4, No. 2, p 145-153, April-June 1975. 1 Fig, 1 tab 27 ref.

Descriptors: *Waste water disposal, *Waste water, *Waste water treatment, *Land management, *Institutional constraints, Research priorities, Agriculture.

Land treatment of waste waters is receiving considerable attention as a waste water management alternative to meet water quality requirements. The many questions raised with the land treatment approach encourage a multidisciplinary planning approach. The systematic investigation of institutional and economic questions should be made concurrent with technical and engineering studies. An investigation of this waste water treatment alternative must address the questions of (i) what institutional arrangements will be used to acquire the use of the necessary land, and (ii) how the land treatment system will be managed. Many factors influence the acreage required for land treatment systems including community size, the type of waste water being treated, management systems used, land availability, and soil type. An extensive area would be required for a large metropolitan area such as Detroit. Smaller communities or power plants would require less area. A number of ways to acquire rights to land are suggested, each with different implications for the affected farmers and the authority responsible for the operation of the system. These include fee simple acquisition, easement purchases, and the formation of waste water cooperatives. Some potential management options for fee simple sites include purchase and manage, and purchase and leaseback.

75:06E-002
CONFLICTS IN WATER TRANSFER FROM IRRIGATION TO MUNICIPAL USE IN SEMIARID ENVIRONMENTS,
Cluff, C.B., DeCook, K.J.
Arizona Water Resources Research Center, Tucson.
Water Resources Bulletin, Vol. 11, No. 5, p 908-918, October 1975. 4 fig, 1 tab, 9 ref.

Descriptors: *Water transfer, *Urbanization, *Irrigation water, *Competing uses, *Water reuse, Land use, *Crop production, Municipal water, Water rights, Water delivery, Water demand, Water law, Water distribution, Legal aspects, Arizona, Alternative water use, Administration, Institutional contraints.

Continued transfer of water from agricultural to urban use is seen as inevitable in Arizona as a result of increased population pressure. Conflict thus generated has been minimized in the Phoenix region where direct urbanization of irrigated land has shifted water supply from one use to another on the same site. This is not the case in the Tucson region, where irrigated lands are more remote. To obtain water for municipal use, the City, entirely dependent on groundwater, is buying and retiring farmlands in an adjacent agricultural area in order to acquire the water rights tied to the land by Arizona water law. Forced farmland retirement has created conflicts and problems including planning for future use of the land, as reclamation is especially difficult in semiarid regions. The loss of food crop production occurs in a time of accelerating world food shortage. Exchange of treated municipal waste-water for irrigation water is being considered, but many attendant problems must be resolved.

Section XXI

WATER RESOURCES PLANNING

ECOLOGIC IMPACT OF WATER DEVELOPMENT (GROUP 06G)

75:06G-001
NATURAL AND AGRICULTURAL ECOSYSTEMS,
Smith, D.F.; Hill, D.M.
College of Advanced Education, Launceston, Tasmania, Australia.
Journal of Environmental Quality, Vol. 4, No. 2, p 143-145, April-June 1975.
1 Fig.

Descriptors: *Ecosystems, Agriculture, Management.

It is argued that the task of creating awareness of environmental problems will require more than the bringing together of papers from a range of disciplines. It will depend on new consciousness and channels of communication. As an example of problems with terms, this paper analyses the use of natural and agricultural ecosystems, suggesting that on all valid criteria these form a continuum, rather than two discrete systems.

75:06G-002
PROCEDURE FOR SELECTING A MINIMAL ENVIRONMENTAL IMPACT ROUTING FOR A WATER CONVEYANCE CANAL,
Wells, D.M.; Mertes, J.D.; Allen, B.L.; Glick, A.H.
Texas Tech Univ., Lubbock; Dept. of Civil Engineering.
Water Resources Bulletin, American Water Resources Association, Vol. 11, No. 4, p 714-733, August 1975. 13 Fig, 1 tab, 4 ref.

Descriptors: *Environmental effects, *Comprehensive planning, *Water resources development, Water conveyance, Canals, Routing, Assessment, Costs, Evaluation, Water supply, Texas, Multiple-purpose projects, Computers.

Several techniques for selecting a least environmental impact corridor have been proposed. Two approaches have been found workable: computer graphics and overlay mapping. This report combines features of both approaches to determine an appropriate routing for a water conveyance canal. The evaluation study was conducted by an interdisciplinary planning team. Environmental factors were mapped and weighted on overlay maps. Alternative routes were identified and carefully studied. Several critical environmental implications were noted. Aesthetic factors, outdoor recreation interpretation, visitor safety and disruption of human and animal travel routes were considered. Evaluation of an environmental analysis procedure requires close examination of the project objectives, scope, and ultimate decision-making body that will ultimately utilize the findings. Size and scale of project play important roles when examining cost figures. The overlay map procedure provides an effective graphic media through which the process of selecting and evaluating alternative linear corridors can be presented. The importance of an interdisciplinary planning team cannot be stressed enough.

RESOURCES DATA

DATA ACQUISITION (GROUP 07B)

75:07B-001
A DUAL-INTERVAL, LIGHT-ACTIVATED SIGNAL GENERATOR--ITS APPLICATION TO SEDIMENT SAMPLING,
Edens, C.D., DeCoursey, D.G.
Agricultural Research Service, United States Department of Agriculture, Chickasha, OK.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 3, p 505-507, May-June 1975. 4 Fig.

Descriptors: *Suspended load, *Sediment transport, *Sediment yield, *Sampling.

Since records of sediment in the field are not available on a continuous basis, water samples must be collected periodically and analyzed for concentration. The device described is a less expensive improvement over available stage and time-activated methods of determining when samples should be taken. To signal the sampler, the device uses light-sensitive rectifiers, activated by light shining through the holes in a disc mounted on the stage recorder.

75:07B-002
BULK DENSITY SAMPLER FOR DEEP SOIL PROFILES,
Holtzclaw, K.M., Rible, J.M., Pratt, P.F.
California University, Riverside.
Soil Science Society of America Proceedings, Vol. 39, No. 6, p 1220-1221, November-December 1975. 4 Fig, 2 tab, 1 ref.

Descriptors: *Sampling, *Bulk density, *Instrumentation, *Soils, *Soil profiles, Drilling, Drilling equipment, Fertilizers, Irrigation, Salts.

A bulk density sampler, adapted from a conventional commercial type, was constructed and used to obtain soil samples at more than 50 sampling sites from depths to 30 m. This sampler increased the speed with which samples were taken because it was readily added to or detached from the drilling unit between sequences of drilling. Evaluations showed that the sampler obtained bulk density values quite comparable to those found with an undisturbed soil core method.

Section XXXII

RESOURCES DATA

EVALUATION, PROCESSING AND PUBLICATION (GROUP 07C)

75:07C-001
A TAX SYSTEM FOR GROUNDWATER MANAGEMENT,
Maddock, T., III, and Haimes, Y.Y.
Geological Survey, Reston, Virginia.
Water Resources Research, Vol. 11, No. 1, p 7-14, February 1975. 4 tab, 14 ref.

Descriptors: *Water management(Applied), *Taxes, *Groundwater resources, Water allocation(Policy), Administration, Water distribution(Applied), Water rights, Water conservation, Irrigation water.

A tax scheme was developed to create an incentive among users to conserve groundwater and reduce the external diseconomies that pumping produces. Quotas are established for wells by using an agricultural management model. If a user pumps more than the quota established for his well, he may be assessed a tax; if a user pumps less than his quota, he may be entitled to a rebate. However, taxes are collected and redistributed in such a way that zero taxes are accumulated from year to year.

Section XXXIII

ENGINEERING WORKS

STRUCTURES (GROUP 08A)

75:08A-001
DRAINAGE MAINTENANCE PROGRAMS IN OHIO COUNTIES,
Nolte, B.H.
The Ohio State University, Columbus, Ohio.
Presented at the 1975 Winter Meeting of the American Society of Agricultural
Engineers, December 15-18, 1975, Chicago, Illinois. 4 p, 2 tab, 7 ref.

Descriptors: *Drainage, *Drainage engineering, Ohio, Cost analysis.

Drainage maintenance programs have increased dramatically in Ohio counties during the past 15 years. Over 11,500 km of channel are being maintained. It is estimated that an additional 970,000 hectares could have better drainage from future outlet construction and maintenance in Ohio.

Section XXXIV

ENGINEERING WORKS

HYDRAULICS (GROUP 08B)

75:08B-001
CORRUGATED PLASTIC DRAIN TUBING USED AS UNDERGROUND CONDUIT,
Misra, R.K.; Beasley, R.P.
Missouri University, Columbia. Department of Agricultural Engineering.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 2, p 260-262, March-April 1975. 7 fig, 2 tab, 2 ref.

Descriptors: *Drains, *Drainage systems, *Excess water (soils), *Hydraulic models, Drainage practices, Pipes, Storm drains, Drainage water, Tiles, Conduits, Subsurface drains, Drainage, Sediment transport, Soils, Movement, Sediments.

Model studies were made to investigate the effect of high water velocity on the extent of soil movement when corrugated plastic drain tubing is used as conduits for underground terrace outlets on steep slopes. No significant amount of sediment was drawn into the tubing, even when the slope was 10% and velocity approached 9 ft. per sec. The magnitude of the flow from the tubing to the soil was low in cohesive soils. But, with less cohesive soils this outflow was greater and there was considerable movement of soil from around the tubing.

75:08B-002
GRAPHIC DETERMINATION OF SUB-MAIN PIPE SIZE FOR SOLID-SET SPRINKLER IRRIGATION ON STEEP, NON-UNIFORM SLOPES,
DeTar, W.R.
Pennsylvania State University, University Park, PA. Department of Agricultural Engineering.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 3, p 503-504, 507, May-June 1975. 3 fig, 1 tab, 1 ref.

Descriptors: *Sprinkler irrigation, *Irrigation, *Irrigation engineering, *Hydraulic design, *Hydraulics.

Analytical solutions to the problem of selecting the proper size for sub-main descending steep, irregular slopes for solid-set irrigation systems can be tedious. A simple graphical method is presented here for obtaining fairly uniform pressures along the sub-main. The method is particularly useful for any solid-set system that repeatedly uses the same lateral size and spacing.

75:08B-003
GENERALIZED NOMOGRAPHIC SOLUTION OF HOOGHOUDT EQUATIONS,
Sakkas, J.G.
Public Power Corporation, Athens (Greece). Hydroelectric Project Design Branch.
Journal of the Irrigation and Drainage Division, Proceedings of American Society of Civil Engineers, Vol. 101, No. IR1, Proceedings Paper 11167, p 21-39, March 1975. 4 fig, 8 tab, 16 ref, 2 append.

Descriptors: *Drainage, *Drains, *Groundwater, *Water Table, Dupuit-Forchheimer theory, Hydraulic conductivity, Rainfall, Irrigation water, Graphical analysis.

The equation of drain spacing developed by Hooghoudt has gained considerable popularity among drainage design engineers because it is sufficiently accurate and possesses a simple mathematical expression. The latter is due to the notion of equivalent depth which he introduced. On the contrary, the application of the equation is quite cumbersome, requiring a trial-and-error procedure. In recent years drainage design for unsteady flow conditions also utilized the notion of equivalent depth. To simplify the use of both the drain spacing and the equivalent depth equations, they were put into dimensionless form containing fewer independent variables. An array of values suffices for quick and inexpensive determination of the equivalent depth. Tables of dimensionless equivalent depth also were prepared. A unique dimensionless nomographic solution of the drain spacing equation was obtained and was displayed in a set of five graphs. Work relevant to Hooghoudt equations by two investigators was analysed with the aid of this analysis.

75:08B-004
POINT SOURCE DISPERSION IN TURBULENT OPEN CHANNELS,
Atesman, K.M.
Bogazici University, Istanbul (Turkey), Department of Mathematics.
Journal of the Hydraulics Division, Proceedings of American Society of Civil Engineers, Vol. 101, No. HY7, Paper 11412, p 785-798, July 1975. 12 fig, 7 ref, 3 append.

Descriptors: *Open channel flow, *Dispersion, *Numerical analysis, *Fluid mechanics, Hydraulics, *Turbulent flow, Distribution, *Velocity, Mathematics, Analysis, Variability.

The effect of the initial distribution of dispersant was investigated by obtaining solutions for different initial instantaneous point and plane source distributions. The governing equations were converted to a tractable system of moment equations which was solved by a numerical method for the zeroth, first, second, third, and fourth moments of the longitudinal concentration distribution. The initial instantaneous point source was located at 0, 0.25, 0.50, 0.75, and 1.0 fractions of the flow depth. During the initial period of dispersion, the convective transport produced a considerable deviation of the moments of the dispersing cloud from the Gaussian long dispersion time conditions. The longitudinal dispersion in a turbulent open-channel flow was found to be strongly dependent on the vertical location of an instantaneous point source.

75:08B-005
DESIGN OF DRIP IRRIGATION MAIN LINES,
Wu, I-p.
Hawaii University, Honolulu, Department of Agricultural Engineering.
Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers, Vol. 101, No. IR4, Proceedings paper No. 11803, p 265-278, December 1975. 9 fig, 3 tab, 12 equ, 9 ref.

Descriptors: *Irrigation, *Irrigation design, *Irrigation systems, *Energy gradient, Optimization, Computer programs, Cost comparisons, Pipes, Design, Size, Simulation analysis, Dynamic programming, Equations, Evaluation, Hazen-Williams equation, Systems analysis.

A drip irrigation system should be designed to meet water requirements of crops, to possess the capacity to provide extra water during unusually dry period, to distribute water into fields with acceptable uniformity, and to have the lowest cost. The main lines of a drip irrigation system can be designed using a straight energy gradient line. This provides a very simple technique for selecting main lines of a drip irrigation system can be designed using a straight energy gradient line. This provides a very simple technique for selecting main line sizes that can be applied especially to evaluate alternative field layouts. An optimal shape of the energy gradient curve is determined as a curve a little bit below the straight energy gradient line. The cost difference between using the straight energy gradient line and the optimal energy gradient line is small, and only around 3%. The developed technique can be used for any kind of topographic condition, uniform or nonuniform, up and down slopes. A straight line energy gradient line can be established when a main line profile is drawn and the available water pressure is determined. The concept can be applied for different types of pipes for sprinkler system design, for water supply pipe systems, or transporting systems for other fluids.

75:08B-006
RESISTANCE TO FLOW IN A COMBINED CHANNEL,
Rice, C.E., Araveeporn, R.
Oklahoma State University, Stillwater. Department of Agricultural Engineering.

Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 5, p 867-872, September-October, 1975. 8 fig, 7 ref.

Descriptors: *Open channel flow, *Flood plains, *Roughness(Hydraulic), Hydraulics, Streams, Roughness coefficient, Channel flow, Hydraulic radius, Mannings equation, Flow, Laboratory tests, Flow resistance.

These experiments studied the flow characteristics in a combined channel with different hydraulic properties, main channel to floodplain widths and areas, slopes, and roughness. The results showed: (1) the hydraulic radius as ordinarily computed in a regular channel results in erroneous discharge values for a combined channel in the depth range immediately above bankfull stage of the main channel; (2) the floodplain flow appeared to have some retarding effect on the flow in a main channel; (3) the combined channel Manning coefficient increased as the floodplain width increased; (4) as the flood plain width decreased, the Manning coefficients for the floodplain and main channel approached the same value at floodplain to main channel depth ratios less than about 0.4; (5) the Manning coefficient for the combined channel reflects the effect of channel geometry as well as the effects of boundary roughness and slope; (6) the hydraulic radius of the floodplain was greater with a divider separating the two sections than without a divider separating the two sections than without a divider for the same depth of flow in the main channel; (7) none of the methods commonly used to compute uniform flow discharge in a combined channel gave good results over the complete range of flow depths; and (8) except at very shallow floodplain depths, there was no difference in water surface elevation between the main channel and floodplain sections.

75:08B-037
VORTEX VELOCITY PREDICTION WITH EMPHASIS DIRECTED TOWARD VORTEX TUBE SEDIMENT TRAP DESIGN,
Edling, R.J., Barfield, B.J., Haan, C.T.,
Agricultural Engineering Department, University of Nebraska, Scottsbluff, Nebraska.
Presented at the 1975 Winter Meeting of the American Society of Agricultural Engineers, December 15-18, 1975. Chicago, Illinois. 25 p, 5 fig, 2 tab, 23 equ, 14 ref.

Descriptors: *Sediments, *Sediment control, *Mathematical model, *Model studies.

The variation in coefficients relating mean velocity, wall velocity and vortex perimeter velocity indicate the values from the empirical technique, if used, should only be considered as rough estimates. The agreement between the expected pattern of stream function and the predicted pattern and approximation of upper slot and mainstream measured velocities by the mathematical model encourage further work with the model. Closer agreement between measured and predicted values is desirable, however, it is felt that the present model gives a first order approximation. It is recommended that changes in the lower boundary conditions for turbulence kinetic energy, dissipation and vorticity be studied. Successful prediction of the point mean velocity and turbulent parameters in complex flows would have many applications.

75:08B-008
ANNOTATED BIBLIOGRAPHY ON TRICKLE IRRIGATION,
Smith, S.W., Walker, W.R.
Colorado State University, Fort Collins, Colorado. Agricultural Engineering Department, Environmental Resources Center.
Information Series No. 16, June 1975. 61 p.
(See 75:03F-039)

75:08B-009
ENERGY GRADIENT LINE FOR DRIP IRRIGATION LATERALS,
Wu, I-p., Gitlin, H.M.
University of Hawaii, Honolulu, Hawaii.

Journal of the Irrigation and Drainage Division, Vol. 101, No. IR4, p 323-326, December 1975. 1 Fig, 14 Equ, 2 Ref, 1 Append.

Descriptors: *Irrigation, *Irrigation design, *Hydraulics, *Irrigation systems, Mathematical analysis, Computers.

The derived mathematical equations for the energy gradient lines can be applied to hydraulic analysis of irrigation systems to both drip and sprinkler. Also, the equations can be used to simplify computer simulations for irrigation system studies and design.

ENGINEERING WORKS

SOIL MECHANICS (GROUP 08D)

75:08D-001
SOIL BULK DENSITIES AFTER THIRTY YEARS UNDER DIFFERENT MANAGEMENT REGIMES,
Northup, M.L.; Boyle, J.R.
Grand Valley State Colleges, Allendale, Mich.
Soil Science Society of America Proceedings, Vol. 39, No. 3, p 588, May-June 1975.

Descriptors: *Soil density, *Bulk density, *Nutrients, *Cultivation, Soil properties, Soil investigations, Soils, Soil compaction.

Variability of soil bulk density must be known to convert accurately concentrations of nutrients in a soil to absolute quantities. This study shows that cultivation increases the bulk density of some soils and simultaneously lowers its variability. Establishment of prairie and pine vegetation on cultivated soils has not created significant differences in this property between vegetation types in 30 years.

ENGINEERING WORKS

ROCK MECHANICS AND GEOLOGY (GROUP 08E)

75:08E-001
SHALE CHISELING - EFFECT ON WATER YIELD,
Shanholtz, V.O.; Burford, J.B.; Engman, E.T.
Virginia Polytechnic Institute and State University, Blacksburg. Agricultural Engineering Department.
American Society of Agricultural Engineers, Vol. 18 No. 6, p 1100-1104, November-December 1975. 6 Fig, 1 Tab, 21 Ref.

Descriptors: *Water yield, *Shales, *Chiseling, Runoff, Erosion, Hydrology.

The Soil and Water Conservation Research Division of the Agricultural Research Division of the Agricultural Research Service (ARS), in cooperation with the Potomac Valley Soil Conservation District, the SCS, and the West Virginia Agricultural Experimental Station initiated hydrologic studies at a site located near Moorefield, West Virginia. Their general objectives were to study the basic factors affecting the hydrograph of surface runoff from pasture on shallow soils formed on shale and to evaluate the effect of shale chiseling on water yield and the hydrograph of surface flow. Generally, this report will be limited to the hydrologic response of the experimental area as reflected by water yields.

Section XXXVII

ENGINEERING WORKS

MATERIALS (GROUP 08G)

75:08G-001
OUTFLOW FROM VARIOUS SUBSURFACE DRAINAGE MATERIALS,
Sommerfeldt, T.G.
Research Station, Agriculture Canada, Lethbridge, Alberta, Canada.
Transactions of the American Society of Agricultural Engineers, Vol. 18, No. 1, p 85-88, 94, January-February 1975. 8 fig. 2 tab, 16 ref.

Descriptors: *Drainage, *Drainage engineering, *Drainage systems, *Drains, Lysimeters.

In lysimeters, the discharge from 55-, and 103-mm-ID perforated plastic drains and 105-mm-ID clay tile drains, with and without gravel or fiberglass envelopes, was determined in CL and FSL soil. In the field, the rate and volume of discharge from 65-mm flexible plastic and 105-mm clay tile drains, installed with fiberglass envelopes in 1968, were determined between 1969 and 1971. The soil, which was coarse textured, was flooded five times in 1969, six times in 1970, and twice in 1971. Generally, no one drain produced greater discharge than another.

75:08G-002
STRUCTURAL PERFORMANCE OF BURIED PLASTIC DRAIN TUBING,
Watkins, R.K., Shupe, O.K., Willardson, L.S.
Engineering Experiment Station
American Society of Agricultural Engineers, Vol. 18 No. 6, p 1082-1084, 1088, November-December 1975. 6 Fig, 5 ref.

Descriptors: *Drainage, *Drains, *Drainage Practices, *Plastic pipes, Plastics, Backfill.

Structural performance tests of corrugated high density polyethylene plastic drain tubing in soil showed that ring deflection is influenced primarily by settlement of the soil around the tubing and secondarily by bedding. The tubing deflects mostly during the backfilling operation. Excessive ring deflection initiates wall buckling and reversal of curvature. Care in forming bedding and in placing sidefill material reduces ring deflection. Reversal of curvature and wall buckling are not total structural failures but do represent performance limits for the tubing.

75:08G-003
ELONGATION CHARACTERISTICS OF CORRUGATED PLASTIC TUBING,
Schwab, G.O., Brehm, R.D.
Ohio State University, Agricultural Engineering Department,
American Society of Agriculture Engineers, Vol. 18 No. 6, p 1114-1117, November-December 1975. 5 Fig 7 ref.

Descriptors: *Plastic pipe, *Plastics, *Drainage, *Drainage design, Backfill.

The widespread adoption of corrugated plastic tubing for subsurface drainage in Europe and in the United States has taken place since about 1962. Because of such rapid acceptance, test procedures and research have not kept pace with usage. Elongation (stretch) is one of many factors which influences the diametral stiffness (also called strength) of corrugated tubing. The objectives of this study were to determine the effect of tube elongation on stiffness, to develop a laboratory test procedure to measure this effect, and to evaluate elongation of tubing installed with different equipment and varying conditions in the field. Tubing sizes were limited to 76, 102, and 152-mm (3,4, and 6-in.) diameters because larger sizes are normally not installed in continuous lengths and stretching is not a problem.

Section XXXVIII

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